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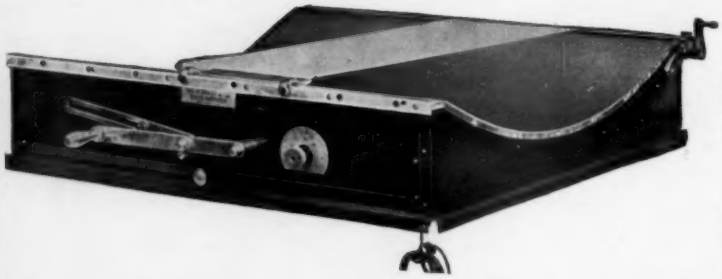

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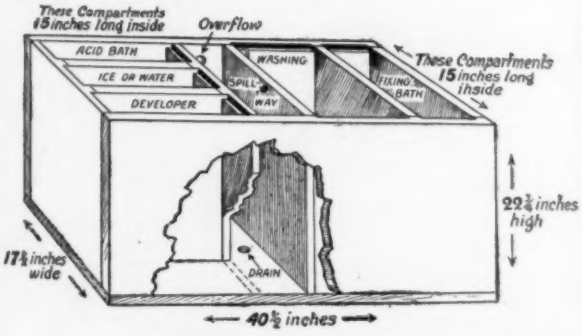

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. X SEPTEMBER, 1923 No. 9

OBSERVATIONS ON THE LATERAL POSITION AND OTHER METHODS OF EXAMINATION OF THE RENAL AND GALL-BLADDER AREAS

BY SIR JOHN THOMSON-WALKER, M.B., F.R.C.S.

AND

ROBERT KNOX, M.D., M.I.E.E.

LONDON, ENGLAND

THE current literature contains few references to the lateral position in the radiography of the kidney and gall-bladder. O'Brien[1] advocates the lateral view, and states that it may obviate the necessity of catheterization of the ureter. A shadow lying against the vertebral shadow may reasonably be stated to be due to a calculus in the kidney. Pfahler[2] suggests an oblique position to throw the shadow of a gall-stone outside that of the kidney shadow. The patient lies obliquely on his right side and the compressor is directed into the epigastric region and tilted so that the cylinder is resting posterior to the right costal border.

TECHNIQUE

In previous descriptions of the lateral position the patient was turned on his right side, and the *x*-rays passed from above either directly or obliquely. There are certain objections to this method. When the patient lies on his side, a varying degree of displacement of the organs under examination takes place. The kidney is especially affected by this change of position. It sinks forward and toward the middle line, and if the mobility of the organ is increased, as in movable kidney, the change in its relation to the vertebral bodies which form the fixed points of a lateral radiogram is considerable. And further, the relation of the kidney to other abdominal organs under examination also undergoes some change. On the other hand, perirenal adhesions will interfere in this position with what might be regarded as a normal variation in the position of the kidney. Moreover, the loss of time and the muscular effort made by the patient in assuming the lateral position may spoil a lateral pyelogram by emptying the renal pelvis.

Some part of the value of a lateral radiogram or pyelogram is the comparison with the anteroposterior view. It is important that both these views should be taken with the patient in the same position. For these reasons it is essential that the lateral negatives should be taken with the patient lying prone or supine, and the latter is the preferable position for the ordinary kidney negative.

Where pyelography is used, a rapid combined technique should be thought out and practiced by the surgeon and radiologist. The essentials in work of this kind are rapidity of action, shortness of exposure,

[1] O'Brien, F. W. The present status of gall-stone diagnosis by the roentgen ray. *Boston M. & S. J.*, 1916, clxxiv, 309.

[2] Pfahler, G. E. An improvement in the technique of gall-bladder diagnosis. AM. J. ROENTGENOL., May, 1915, ii, 774.

and a tube of the degree of hardness best suited to the conditions under investigation. With a table of the description shown, it is possible to screen from below and take negatives from above and from the lateral aspect in a very short time, without in any way disturbing the patient. When catheterization of the ureter is required, the surgeon can readily get at the patient, and when the pelvis is injected, three or more negatives can be exposed in different positions, and the time employed need not exceed a few seconds for each exposure.

An important feature in the technique is the employment of the duplitized film with two intensifying screens, one on either side of the film. This combination diminishes the exposure necessary for the production of high-class negatives. In hardly any case need the exposure exceed two seconds, and the majority are made in one second or less. Coolidge tubes or gas tubes can be used. When the latter are employed, it is important not to pass too many discharges through the tube in quick succession, because of the heating effect. As a rule, the short exposure required for kidney and gall-bladder work is not likely to disturb seriously the vacuum, if care is taken to keep the tube in a suitable condition. In this the duplitized films and screens are a boon, and undoubtedly they are responsible for a great improvement in the quality of the negatives produced.

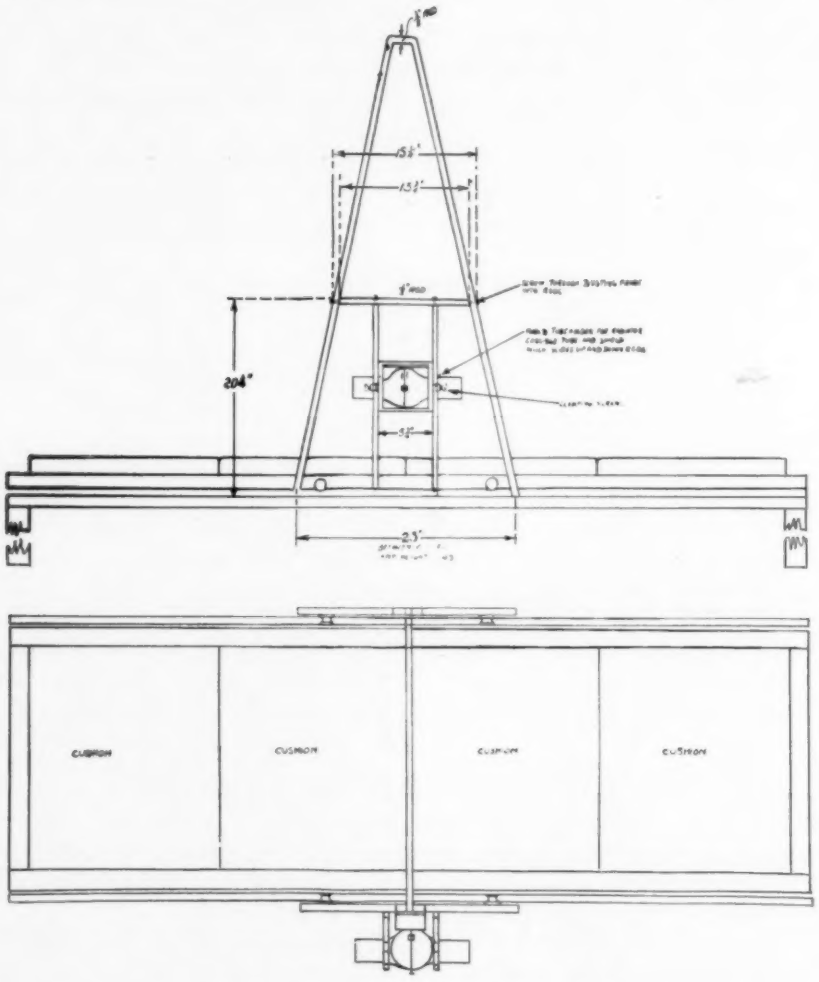

FIG. 1. Apparatus for lateral radiography.

Lateral radiography may be used alone or with the addition of an opaque catheter in the ureter, or of pyelography. A note

The ureteric catheter is passed in the recumbent position. The catheter is marked in centimeters and the distance

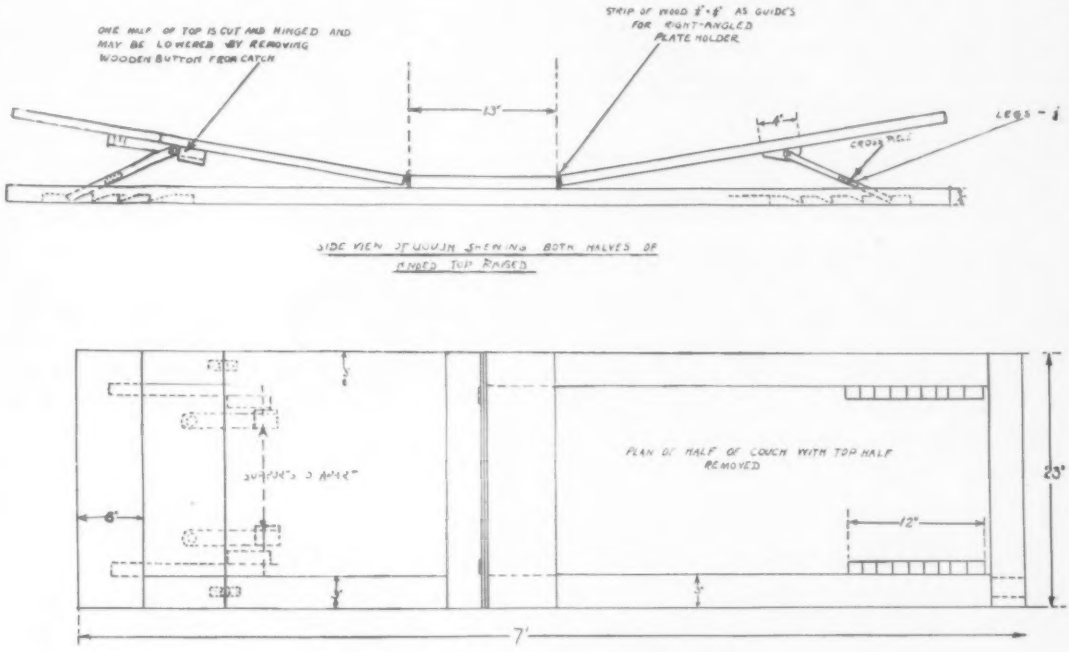
ONE HALF OF TOP IS CUT AND HINGED AND MAY BE LOWERED BY REMOVING WOODEN BUTTON FROM CATCH
STRIP OF WOOD ½"×½" AS GUIDES FOR RIGHT-ANGLED PLATE HOLDER
13"
4"
LEGS - 4
SIDE VIEW OF COUCH SHEWING BOTH HALVES OF HINGED TOP RAISED
PLAN OF HALF OF COUCH WITH TOP HALF REMOVED
23"
12"
6"
7'

Fig. 2. Table-top for lateral radiography.

may therefore be made in regard to the latter method of examination:

The best catheters in use in pyelography are those made in Paris. With care they may be sterilized by boiling. They are supple and retain a good surface, and the lumen compared with the total caliber is large, while they throw a heavy shadow.

that it passes up the ureter should be carefully noted, as it disappears into the orifice. In the average patient 25 to 30 cm. is the usual length of catheter that disappears before it is arrested. The point of the catheter passes into the upper calyx in all cases where the ureter and pelvis are in the normal alignment, and where there

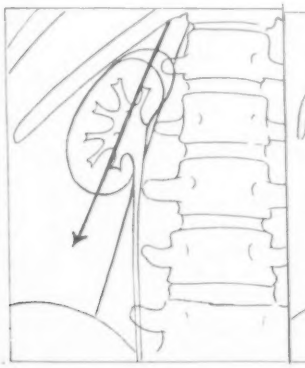

Fig. 3. Diagram showing normal position of kidney.

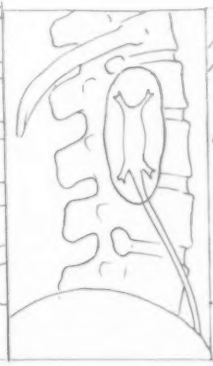

Fig. 4. Diagram showing position of kidney, renal pelvis and ureter in lateral view.

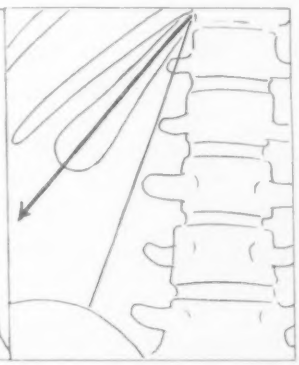

Fig. 5. Diagram showing position and axis of gall-bladder.

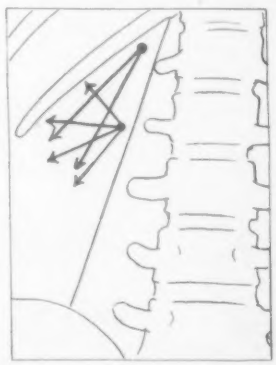

Fig. 6. Diagram of radiating lines of renal and biliary calculi.

is no dilatation of the pelvis. When a catheter with terminal eye is being used, it should be withdrawn ½ cm. Neglect of this precaution may lead to imperfect filling of the pelvis and the remaining calices, for the patient feels pain when the upper calyx is distended, and the operator is misled into believing that the pelvis is already full.

If it is desired to study the contour of the uretero-pelvic junction, the catheter should

FIG. 7. Lateral pyelogram showing pelvis of kidney over shadow of body of second lumbar vertebra, opaque catheter in ureter, calcified glands in front of ureter and spine and gas-filled hepatic flexure of colon in front of renal pelvis.

be withdrawn about 2 cm. after it has passed the full length and has been arrested. The opaque fluid shows the natural contour of the upper ureter and its relation to the pelvis, which the rigid catheter would otherwise modify to some degree. If the catheter is arrested in the ureter before reaching the renal pelvis it is still possible to inject the fluid and fill the renal pelvis. Very rarely obstruction at the uretero-pelvic junction will prevent the fluid passing into the renal pelvis, and it is returned alongside the catheter to the bladder.

Sodium bromide solution (20 per cent) introduced by Weld, has in our practice superceded other opaque fluids. It throws a shadow rather less dense than that thrown by collargol, but sufficiently heavy for all routine work. Sodium bromide is irritating to the bladder, and when it escapes down the catheter the first intimation will be an intense desire to pass water. In solutions stronger than 20 per cent it is irritating to the renal pelvis. The solution should be sterilized by boiling, and oxycyanide of mercury (1 in 8,000) added to keep it aseptic. It is an advantage to have it slightly warmed. After passing the catheter a glass syringe (20 c.c. capacity) is attached to it by means of a small rubber connection introduced by one of the writers.[1] The pelvis is now emptied of its contents by suction with the syringe. This is a necessary precaution, for if dilatation is present, a quantity of fluid is constantly retained in the dilated pelvis, and into this the opaque fluid is injected. This dilution of the opaque fluid produces a poor shadow. Before injecting the opaque fluid the film is placed in position and the tube adjusted. If compression is required this is applied now, so that no further manipulation is necessary, and no time is wasted after the renal pelvis is filled before making the exposure. The examination having been completed, the renal pelvis is at once emptied of its contents, by suction with the syringe. Should it be necessary to have the film developed and the catheter retained for further exposure, the pelvis is emptied by means of the syringe and the catheter allowed to remain in the ureter in the interval.

INTERPRETATION OF ANTEROPOSTERIOR AND LATERAL RADIOGRAMS OR PYELOGRAMS OF THE UPPER ABDOMEN

An accurate knowledge of the size, shape, position and relation of the organs in this region is necessary for the reading of the radiograms.[2]

The liver, gall-bladder and bile ducts, the kidney, renal pelvis and upper ureter, the suprarenal capsule, the pancreas and the pancreatic duct, the duodenum and hepatic flexure of the colon and certain

[1] Thomson-Walker, J. Renal Function in Urinary Surgery. London, 1907.

[2] Knox, R. Radiography in the Examination of the Liver, Gall-bladder and Bile Ducts. London, 1919.

abdominal lymphatic glands are all crowded into a comparatively small space, in the right side of the upper abdomen, and in a given case the symptoms and the radiographic findings may lead to a discussion in regard to the pathology of any of these organs. A few notes may therefore be made in regard to the organs more commonly concerned in obscure cases.

The anatomical points upon which localization in an anteroposterior view of this region depends are the last two ribs, especially the twelfth rib, the bodies and transverse processes of the lumbar vertebrae, the crest of the ilium and the oblique outer margin of the psoas muscle. In the lateral view the ribs give no help except to mark the twelfth dorsal vertebra. The bodies of the lumbar vertebrae and the spines of these vertebrae are the anatomical structures by which localization is estimated in the lateral position. The iliac crest obscures some part of the field, but does not help in the localization.

In the anteroposterior position the kidney lies in the upper part of the space bounded by the twelfth rib, the outer border of the psoas muscle internally, and the crest of the ilium below. The long axis is obliquely set so that the inner border of the upper and lower poles closely approximates to the oblique line of the psoas muscle. The pelvis lies at the outer border of the psoas at the level of the transverse process of the second lumbar vertebra. From this the ureter passes downward on to the transverse processes of the third, fourth, and fifth lumbar vertebrae. This position is modified by respiration and by position. With full expiration the upper pole ascends behind the twelfth rib, and with full inspiration the kidney descends about half the breadth of a lumbar vertebral body. In the vertical position there is a similar descent of the kidney.

FIG. 8. Lateral skiagram of case of calculus in the common bile duct. A round dense shadow situated well in front of the vertebral body.

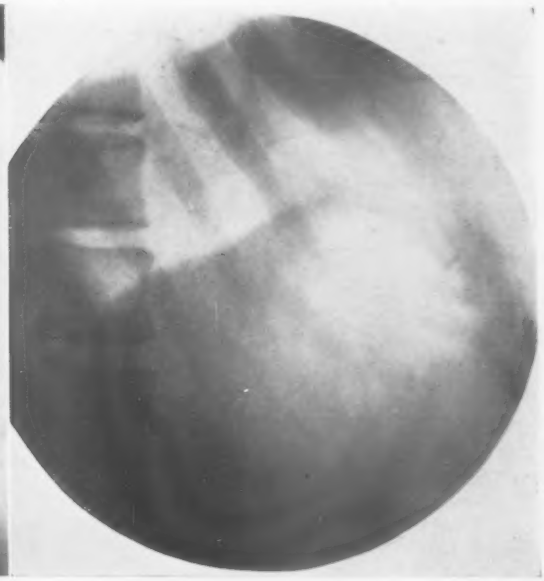

FIG. 9. Lateral view of stones free in gall-bladder.

The shadow of a normal kidney can be recognized in a radiogram of first quality. The lower pole and the inner border are most evident, and the upper pole less defined. A pyelogram shows the lumbar segment of the ureter, the pelvis of the kidney and the calices.

The ureter lies on the transverse processes of the fifth and the fourth lumbar vertebrae, and on the tip of the transverse process of the third lumbar vertebra. The pelvis is opposite the second lumbar transverse process external to the outer border of the psoas muscle.

In the normal pelvis and calices normally placed the following five points should be present.[1]

1. The pelvis is trumpet-shaped, the upper and inner margin being vertical or curving gradually outward, while the lower or outer margin curves outward on a small arc.

2. A catheter passed up the ureter will pass onward vertically or with a gentle outward curve to enter the upper calyx.

3. The calices seen in profile have a constricted neck and a terminal cup into

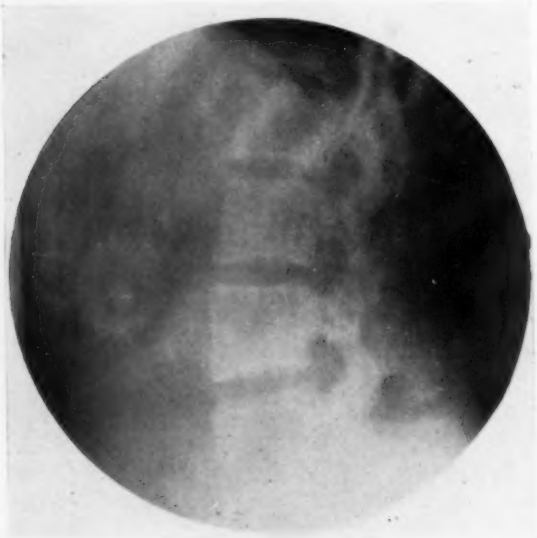

FIG. 10. Lateral view of gall-bladder with gall-stones in duct and detritus at fundus.

which the apex of the pyramid projects. Seen in face either looking toward the plate or away from it a calyx appears as a round dark area with a lighter center. The calices seen in profile are more easily recognized than those in face.

In some negatives all the calices are taken in profile. Usually one or two calices are seen in face. It may very rarely happen that all the calices are taken in face.

4. The outer border of the upper ureter, the lower border of the pelvis, and the inner border of the lowest calyx form a curve, the uretero-calicine curve, which amounts to half a circle. Pronounced changes in this curve are seen in dilatation of the pelvis and in the displacement of the kidney.

[1] Thomson-Walker. J. *Cong. internat. Assn.*, Paris, 1921.

5. The ureter passes so gradually into the pelvis that no definite point can be distinguished as representing the uretero-pelvic junction. Where the junction is marked by a sudden change of contour the condition is abnormal.

In the lateral view the kidney lies on the sides of the bodies of the first, second and upper part of the third lumbar vertebrae. Its shadow cannot, even in a radiogram of first quality, be defined. In a pyelogram with opaque catheter in the ureter, the pelvis and abdominal segment of the ureter are shown. The pelvis throws an

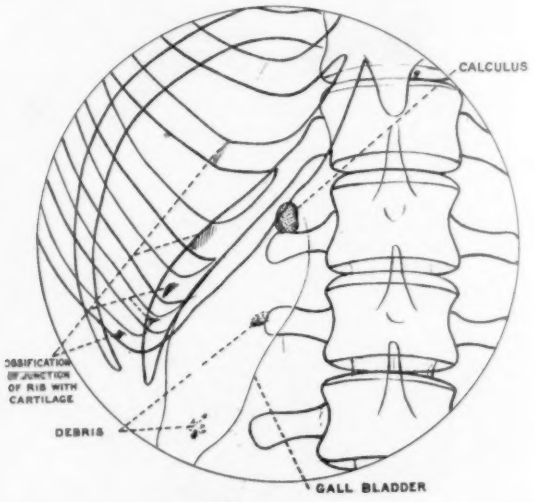

FIG. 11. Line drawing of gall-bladder showing stone at opening of cystic duct, drawn from the antero-posterior view of Figure 10.

elongated oval shadow tapering at its lower extremity and lying in the shadow of the body of the second lumbar vertebra. From this the shadows of the calices project to right and left, that is, anteriorly and posteriorly. The upper calices project above the shadow of the pelvis like horns, and the lower calices downward below the pelvis. The ureter passes downward and forward, crossing the body of the third lumbar vertebra, and reaching the line of the anterior border at the lower border of the third and the upper border of the fourth lumbar body.

The suprarenal capsule lies in the angle between the twelfth rib and the body of the first lumbar vertebra, but it may lie higher than this behind the twelfth rib or just above it.

The normal gall-bladder has been demonstrated on several occasions. It should be the aim of all radiologists to show the lower border of the liver and any irregularity projecting below that border. If a normal gall-bladder is distended with bile, it should show a projecting bulge at the level of the ninth costal cartilage. The density may not be greater than that of the liver.

In the majority of pathological conditions affecting the gall-bladder, including biliary calculi, the accompanying cholocystitis leads to a thickening of the whole of the wall of the organ. This thickened wall will show in a skiagram which is of the proper quality.

Where the shadows of a collection of gall-stones are demonstrated, the shape of the organ may be distinguished. The position of the gall-bladder varies more than that of the kidney in different individuals. It may occupy the space between the twelfth rib and the outer border of the psoas muscle usually occupied by the kidney. The shadow is an elongated pear-shape with the apex above. It lies nearer to the twelfth rib than does the kidney shadow, and its long axis is not parallel to the outer border of the psoas muscle shadow, as in that of the kidney, but bisects the angle between the twelfth rib and the psoas. The space between the inner border of the pyriform gall-bladder shadow and the outer border of the psoas shadow is much greater than that between the kidney and the psoas. Very considerable variations are found in the relation of the gall-bladder to the bony landmarks, and this is not always due to the varying position of the gall-bladder, for the twelfth rib may be long and very oblique, so that the costo-vertebral angle is narrow. The gall-bladder shadow is then in relation to the twelfth rib and the last costal space. The long axis may be more vertical or more transverse. In the lateral view the gall-bladder lies anterior to the lumbar vertebrae and reaches as low as the third lumbar vertebra. These points ascertained by radiography are confirmed by a study of the anatomy of a cross-section of the body at this region.

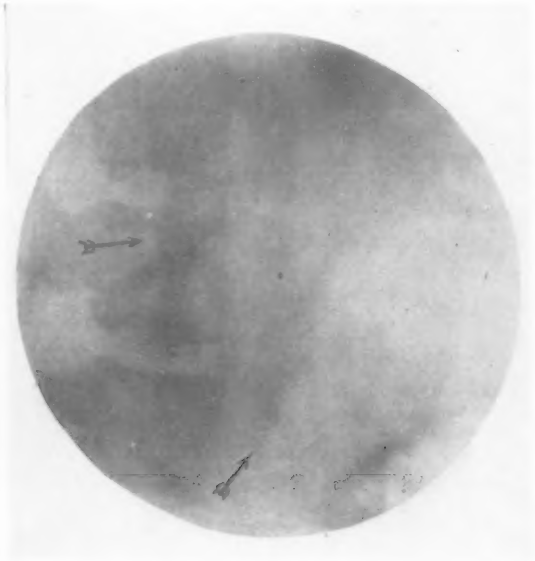

FIG. 12. Lateral view showing kidney stones on vertebral bodies and gall-stone anterior to spine and lower down.

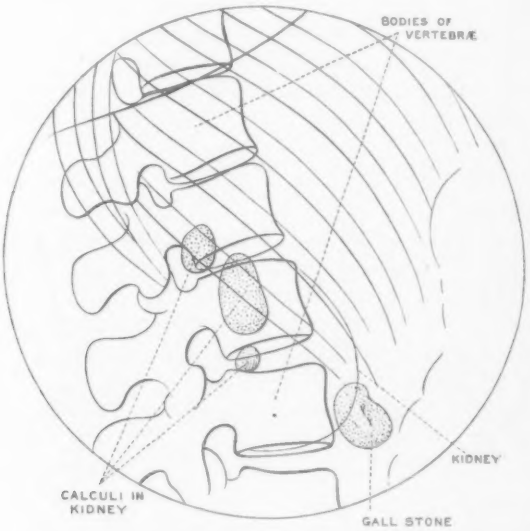

FIG. 13. Diagram of case shown in Figure 12.

VARIATIONS IN DISEASED CONDITIONS

While the preceding descriptions hold good for cases where little change has occurred in the size or position of the organs, some variations may be brought about by disease. The movable kidney has a wide excursion, and may be found partly below the iliac crest in the antero-posterior view. It should be noted that

mobility of the kidney may change the relation of the organ to the vertebral bodies in lateral radiography. If a patient with a movable kidney is turned on the side, the organ falls forward, and a stone shadow may be thrown in front of the anterior margin of the bodies of the vertebrae. It is obvious, therefore, that the lateral view must be taken with the patient lying on his back in order to avoid this displacement.

When the kidney is greatly enlarged as in pyonephrosis, the organ rises out of the paravertebral hollow, and with the patient lying on the back, stone shadows in such a kidney may appear in front of the vertebral bodies in the lateral view. There is, however, little difficulty in diagnosis in such cases, for the kidney that has reached this size is readily palpable, and easily recognized.

The wall of the gall-bladder, which is the seat of chronic inflammation, is thickened, and frequently throws a shadow comparable in density to that of the kidney, so that the outline can be traced in the skiagrams. It does not follow, however, that where a definite shadow of the gall-bladder is shown the organ is necessarily pathological. A normal gall-bladder which is dilated with bile and projects well below the border of the liver, will be shown in a negative of good quality. Attention was first called to this point by the work of Leonard and George on "The Pathological Gall-bladder," and our experience confirms this observation. Failure to appreciate this important fact has led to the exploration of a normal gall-bladder under the mistaken impression that a defined gall-bladder shadow in a skiagram must indicate a pathological condition.

In order to attain familiarity with the possibilities of demonstrating the normal gall-bladder, a large number of negatives of this region should be carefully examined. It will then become apparent that the outline of the gall-bladder is shown in a considerable proportion of these.

The gall-bladder which contains gall-stones may be so enlarged as to project well below the level of the kidney in the anteroposterior view, and in the lateral, reaching as low as the middle of the body of the fourth lumbar vertebra. When greatly distended, it loses its pear shape and becomes more rounded, but it never assumes the shape and outline of the kidney. It may occupy practically the same area as the kidney, and if only the lower half of the gall-bladder shadow is seen it might easily be mistaken for the lower pole of the kidney.

In chronic cholecystitis adhesions form between the gall-bladder and the surrounding structures, and these tend to modify its shape when it is distended with bile, mucus or mucopus. It may assume a sausage shape, or have a curved outline, the curvature being partly outward and partly inward. When the gall-bladder is distended with fluid and contains gall-stones, its shape as seen in the skiagram may vary from time to time. When the fluid contents are expelled it contracts. Thus it may be pear-shaped at one examination and sausage-shaped at a subsequent one. The organ may become fixed by adhesions to the duodenum or colon, so that the direction of the shadow will vary and instead of pointing directly downward or downward and outward, it is displaced inward.

Very rarely when inflammatory conditions have subsided, calcareous deposits may form in the walls and throw a shadow in the radiogram. This may simulate calcareous deposit on the wall of a liver abscess which has subsided, and it is difficult to differentiate between the two.

A small hydatid cyst may cause difficulty. The clinical history will be an important factor in deciding the nature of the shadow. The hepatic flexure of the colon passes across the kidney and the pelvis in the anteroposterior view, and if the preparation of the patient has been imperfect or inadequate the kidney shadow may be obliterated by gas distention of the bowels. We have found that salts are liable to cause troublesome gas distention of the colon. The best method of preparation is to give small doses of castor-oil, licorice powder, cascara or confection of senna on two nights before the examination, with a low diet for a day, and avoidance of food on the morning of examination. In the lateral view the hepatic flexure

of the colon will be seen in front of the second and third lumbar vertebrae, lying immediately over the pelvis of the kidney in a lateral pyelography.

PSOAS ABSCESS

Though not at all common, this condition in certain forms may throw a shadow which simulates a distended gall-bladder. Of a large number of cases of spinal caries examined, only one was found which could give rise to difficulty in diagnosis. The chief diagnostic point is the presence of

FIG. 14. Lateral pyelogram of case of small shadows in kidney and gall-bladder region.

caries of the spine at a higher level than the abscess. The shadow of the abscess may be long and pear-shaped, and present a decided curve in its outline. In the case referred to there existed unmistakable evidence of spinal caries involving two or three of the bodies of the dorsal vertebrae. The abscess presented a long banana-shaped form, narrow at its upper extremity and widening as it proceeded downwards, until at the level of the pubic arch it showed a definite rounded outline. The sac of the abscess was distended with pus and debris, and in no part was there any indication of a varying density such as would be shown by gall-stones. The diagnosis of psoas abscess was made, and confirmed by operation.

SHADOWS IN THE KIDNEY AND GALL-BLADDER

So far as radiology is concerned, there are a number of pathological conditions which present themselves for diagnosis in a limited area in the upper abdomen. Of these, lesions of the kidney and ureter come first in order of importance and frequency of occurrence. Next to the kidney come lesions of the gall-bladder and bile ducts, and then lesions of the pancreas, particularly calculus of the pancreatic duct. The duodenum may also have to be con-

FIG. 15. Lateral view. An irregular dense shadow in front of the interspace between third and fourth lumbar vertebrae, ½ in. in front of the anterior aspect of the bodies of the lumbar vertebrae. Calcareous gland.

sidered, and lesions of the suprarenal glands, such as calcareous deposit or growth, are occasionally the subject of diagnosis. Lesions of the liver, especially if chronic, and the seat of degenerative calcareous changes, will at times present difficulties in differentiation. Calcification in the lymphatic glands will throw dense shadows, which may be confused with renal or biliary calculi. Calcification of

areas of the aortic walls may give doubtful shadows, as will also dilatation of the abdominal aorta in that region. Foreign bodies in the stomach and intestines may lead to discussion, but are easy to identify.

The chief radiographic difficulty is to distinguish between renal and gall-bladder lesions, especially calculi in these organs. A urinary stone throws a uniformly dense shadow in the position of the calices, the renal pelvis or the upper ureter. A gall-stone throws a shadow in the area of the gall-bladder or bile ducts, which is not generally uniformly opaque. There are many exceptions to these statements, and moreover, kidney and gall-bladder areas overlap. It follows that difficulties arise in recognizing the nature and position of these shadows. To these difficulties we wish to refer.

THE POSITION OF A SHADOW IN THE KIDNEY-GALL-BLADDER AREA

The stereoscopic method has many valuable applications and the measure of success to which it may be used by an expert was demonstrated by the late Dr. Macleod of Shanghai.[1]

The method is open to the grave objection that an accurate result can only be obtained where the two negatives are taken with a very short interval between the exposures. The slightest movement, respiratory or otherwise, on the part of the patient between the exposures, may lead to serious error in the subsequent calculations. And when all has been accomplished it is only possible to say that the calculus lies at a definite depth from the skin surface which during the exposure was in juxtaposition with the sensitive surface of the film or plate. To localize accurately the depth of the shadow from the surface is nevertheless of definite clinical value, and where the different organs lie in superimposed planes the knowledge of the plane proper to each organ will give an additional factor necessary for the localization in one or other organ.

The valuable table prepared by Dr. J. Metcalfe and the late Dr. Keys Wells gives the following data, which are useful in estimating depth measurements either in stereoscopy or with negatives obtained in three positions:

Thickness of abdominal wall from back to:

1. Transverse process of third lumbar vertebra = 4 to 5 cm.
2. Anterior level of third lumbar vertebra = 11 cm.
3. Anterior level of psoas muscle = 15 cm.

From these data it is possible to estimate whether a shadow representing a stone is inside or outside a kidney which is normal in position and size. The position of the gall-bladder in relation to the abdominal wall is not given in this table. If the thickness of the abdominal wall at a point 1 cm. on either side of the middle line at the level of the umbilicus is taken as 3 cm., the fundus of the gall-bladder is known to lie close to the posterior surface of the anterior abdominal wall. The gall-bladder is from 7 to 10 cm. long, and is directed backward and toward the middle line. A gall-stone may therefore be situated at any point between 3 cm. and 13 cm. from the anterior surface of the abdomen. It must be admitted, however, that the organs do not occupy exactly superimposed planes, but have a much less regular relationship; and further, an organ such as the kidney does not, on account of its mobility or abnormal mobility, or from its enlargement in disease, necessarily occupy the plane normally assigned to it, or retain its accepted relationship to other organs. It follows, therefore, that there are limitations in the stereoscopic method that do not apply to the lateral method.

A gall-stone situated at the neck of the gall-bladder, or in the cystic or common duct will have a position very different from that of a stone in the body of the gall-bladder, especially if the latter is distended and displaced forward and downward. It may be in front of the kidney shadow and cause great difficulty in diagnosis, even when all positions are employed. The stone in the common duct will lie just in front of the anterior border of the lumbar vertebrae when the patient is examined in the lateral position.

[1] Macleod, Neil. An unexpected solution of a pelvic radiograph problem. *Arch. Radiol. & Electroth.*, Jan., 1921, xxv, 234.

Some of the difficulties that arise are illustrated by the radiograms obtained during the examination of a case which came under the notice of the writers. Multiple shadows were shown. It was determined definitely that a large shadow in the renal region was due to a calculus filling the renal pelvis and extending into the calices. At the lower limit of the renal calculus a large oval shadow was seen. This had a central opacity surrounding which was a less opaque area, and at the extreme periphery an irregularly dense outline was seen. (Figs. 12 and 13.) Doubt arose regarding this shadow, although it certainly had the characteristic appearance of a large gall-stone. In the anteroposterior view first taken, it was overlapped in part by the calculus in the kidney, and the shadow of the kidney also overlapped it. But in a subsequent exposure it lay below the shadow of the kidney stone. An opaque catheter was introduced into the ureter. It passed the lower shadow and entered the kidney at the upper limit of the renal calculus. A lateral radiogram showed clearly that the doubtful shadow lay in front of the spine, and the diagnosis of gall-stone was made. At operation the kidney was removed by the lumbar route, and was found to contain large calculi in branching arrangement. The gall-bladder was opened by the anterior route, and one large and fifty small stones were removed. The examination in this case shows how very thorough must be the technique when doubtful conditions exist. In the radiograms taken in the anteroposterior and the posteroanterior positions, several faint shadows due to biliary calculi were seen, but the majority of the small biliary calculi were lost in the renal shadow and that of the kidney stone. The lateral position and the opaque catheter gave much help in the diagnosis. Stereoscopic radiograms would have been useful in this case, though it is doubtful if one could have made any definite statement unless accurate depth measurement had also been made.

FIG. 16. Lateral view of branching kidney calculi.

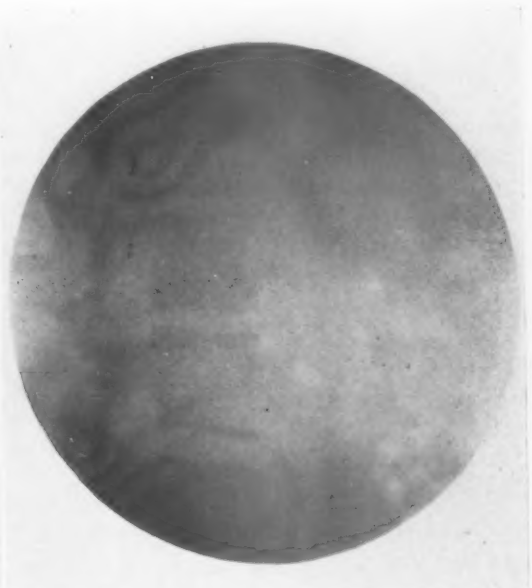

FIG. 17. Lateral view of stone in calyx showing stone shadow behind the vertebral bodies.

SIZE AND SHAPE

Both renal and biliary calculi may attain a very large size, and both may, when large, have an oval or round shape. A large round or oval shadow, if thrown by a kidney stone, will be accompanied by a large kidney, which is readily palpated in the loin, for in such cases the kidney is usually dilated with urine or pus. It may be stated, therefore, that where a large oval

or round shadow appears in the loin without urinary symptoms and the kidney is not palpable, the shadow is more likely to be thrown by a gall-stone than by a kidney stone. There are, however, some remarkable exceptions to this generalization. A wedge-shaped shadow is characteristic of a stone in the renal pelvis. An irregular or branching shadow is never due to a biliary calculus, and a branching shadow is certainly renal. The difficulty seldom arises over the large calculi, but over a small oval or round shadow, which might be thrown by a renal or by a biliary calculus.

DENSITY AND UNIFORMITY OF THE SHADOWS

A renal calculus will, as a rule, throw a heavier shadow than a biliary calculus. A renal calculus shadow is usually homogeneous, and a gall-stone usually shows some detail of structure, the most characteristic of which is a marginal ring of increased density. This ring, together with a central nucleus, gives a shadow which is peculiarly characteristic of a gall-stone. But there are misleading shadows where the character of the renal stone shadow resembles that of a gall-stone. An example was a case of stone in the kidney where the nucleus and denser margin were both clearly seen, and which gave rise to serious doubt regarding its position. On the other hand, a gall-stone may give a very dense shadow which would indicate, if the density were taken as a guide, that its position was in the kidney. On the evidence of such a uniformly dense rounded shadow in the right renal region, a patient had the kidney explored for stone with negative results, before she consulted one of the writers. When examined, she complained of pain in the right upper abdomen, but had never suffered from hematuria or of jaundice. Pyelography showed that the shadow lay apart from the renal pelvis and calices, and the gall-bladder was opened and the stone removed.

Taking the majority of shadows of calculi, it may, however, be assumed that the large dense homogeneous shadow is more likely to be due to calculus in the kidney than one situated in the gall-bladder, but that the nature and appearance of the shadow cannot be taken as an absolute diagnostic guide.

Faint shadows in the gall-bladder and kidney regions have been overlooked because the type of negative does not show sufficient detail. When the negative is very dense from overexposure, overdevelopment, or both, a very powerful illuminant will reveal an evidence of a shadow which should be helpful. The detail of gall-stones may be faintly perceptible to ordinary vision in ordinary illumination, and oblique illumination may give assistance. Colored screens may be interposed between the negative and the source of illumination. Such faint shadows have generally been attributed to bowel contents or other extraneous matter. Experience shows that although a number of calculi may be present in the gall-bladder, only a small number may throw a shadow. Yet a single distinctive shadow is sufficient for diagnosis.

There is a type of kidney stone that may give rise to considerable difficulty in obtaining a shadow, and when a shadow is demonstrated it is so faint that doubt as to its character may arise. This is a thin flat stone lying with its flat surfaces facing anteroposteriorly. Such a stone is difficult to find at operation. It lies wedged in the pelvis, and is so thin that it cannot be felt on palpation outside the kidney or pelvis. It is easily missed with an exploring probe, and may even be missed by the finger. The faintness of the shadow in these cases, when the final diagnosis rests upon the *x*-ray examination, always raises the question as to whether it is a gall-stone.

It has been pointed out by Carman[1] that gall-stones may be of less density than the medium in which they lie, and under these conditions the gall-stones are indicated by an area of less opacity than the surrounding structures. They will therefore show on the negative as darker areas. And this especially occurs in gallstones lying in a bladder distended with bile, pus, or mucopus. In this relationship it may be noted that Dr. Simon refers to a case where a lesser opacity gave rise to

[1] Carman, R. D. The Roentgen Diagnosis of Diseases of the Alimentary Canal. Philadelphia, 1921.

suspicion of the presence of a stone situated in the common duct. Similarly in the opaque meal examination, a deformity of the opaque material may be caused by a gall-stone of low opacity.

The following experiment demonstrates conclusively the accuracy of these observations. A large gall-stone composed chiefly of cholesterin was *x*-rayed in the usual way. It was then placed against a film, and a box containing water was placed between it and the *x*-ray tube. A very definite "positive" shadow was obtained. The stone was now wrapped in a thin sheet of gutta-percha tissue and placed in the water close to the distal side of the box. The negative produced a "negative" shadow. The water had absorbed relatively more of the radiations than the gall-stone. The gall-stone displaced a volume of water equal to its bulk, and the quantity of water so displaced had a relatively higher absorption equivalent than the gall-stone which displaced it. It is therefore possible that in examining negatives for the presence of gall-stones, we look for the wrong type of shadow, and may altogether miss the stone if we fail to realize that a small "negative" opacity may indicate the presence of the object for which we are searching.

In this relationship it is interesting to note that Dr. Lynham, whose attention has been called to this point by the experimental work described, recently diagnosed the presence of gall-stones on the negative shadow.

GROUPING OF SHADOWS AND THE EFFECT OF RESPIRATION

When a number of shadows are present, their arrangement will conform, to some extent, to the shape and axis of the cavity in which they lie. Calculi in the kidney and calices tend to radiate outward from the position of the pelvis which lies at the edges of the psoas at the level of the transverse process of the second lumbar vertebra. Shadows in the gall-bladder, on the other hand, radiate downward or downward and outward from the angle formed by the twelfth rib and the body of the twelfth lumbar vertebra. Where a line of calculi can be traced, therefore, the line of the renal calculi would tend to cross that of the biliary calculi.

In a male patient there had been two operations on the kidney for mobility and an abdominal exploration, and indefinite pain persisted over the right upper abdomen. The *x*-ray examination showed four small shadows lying like a string of beads

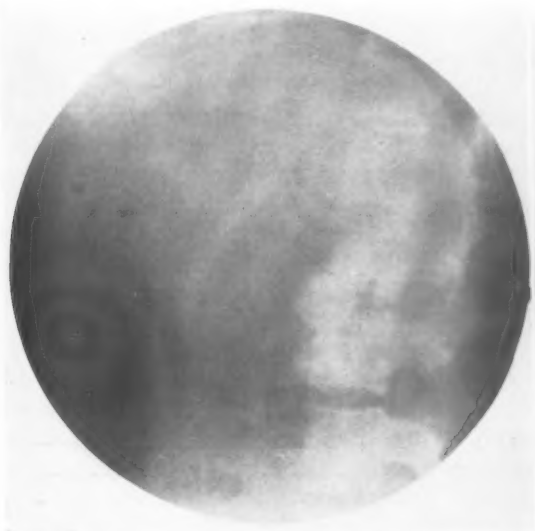

FIG. 18. Kidney stone resembling gall-stone in lateral view, excluding gall-stone. Both kidneys contained stones, on the right side one oval calculus had the *x*-ray appearance of a gall-stone.

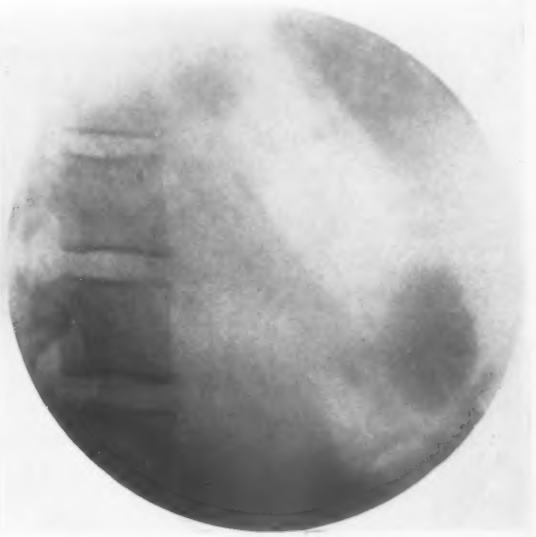

FIG. 19. Large gall-stone in lateral view.

in the kidney-gall-bladder area. Pyelography showed a normal renal pelvis, and demonstrated the calices except the upper calyx, the position and direction of which, radiating from the pelvis, was represented by the string of shadows. The axis of this line of shadows crossed that which would represent a string of calculi in the gall-bladder ducts. The shadows were also denser and more uniformly opaque than would be expected in gall-bladder stone shadows, and the diagnosis of kidney stones was made on these points, and subsequently confirmed by abdominal exploration and examination of the gall-bladder.

The grouping of a large mass of renal calculi into a main mass in the pelvis with

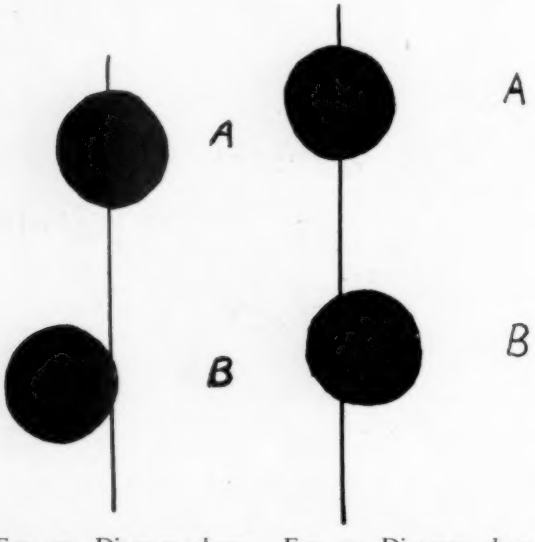

FIG. 20. Diagram showing direction of movement of kidney stones.

FIG. 21. Diagram showing direction of movement of gall-stones in gall-bladder.

radiating branches in the calices, and the mosaic of shadows produced by the gall-bladder filled with gall-stones, are each so characteristic of the respective organs as to leave no margin of error. In some difficult cases where only one shadow is present, the following method has proved useful:

Two exposures are made on one plate, the one in full expiration and the other in full inspiration. The direction and extent of movement are noted. The kidney stone moves downward and outward, and the extent of the movement is less than that of the gall-bladder under the same conditions, i.e., where the plate is nearest to the spine, as in the usual kidney position. The movement of the shadow of the gall-stone, which is lying free in the cavity and at the lowest point of the gall-bladder will be almost directly downward with a slight displacement inward, and will show a greater amount of movement.

A gall-stone in the common duct or the cystic duct is fixed, its displacement will be less marked on deep inspiration, and its line of movement will approximate that of the kidney stone.

PYELOGRAPHY

By pyelography the shadow which may lie within the kidney area, and actually within the limits of the kidney shadow, may be proved to lie outside the kidney. The shadow of a kidney stone will lie engulfed in or at least be continuous with the shadow of the renal pelvis or one of the calices. A shadow which lies apart from the pelvis or calices, as shown by pyelography, is not thrown by a renal calculus. The so-called cortical stone, a stone embedded in the renal cortex, and not connected with the calyx, has no existence outside the older textbooks. Where therefore, the suspicious shadow is shown to lie apart from the pelvis and calices as shown by pyelography, the diagnosis will be a gall-stone and not a kidney stone.

But where the shadow is continuous with or superimposed upon a calyx or the pelvis, the stone may be, and usually is, a kidney stone. Fallacies do exist in regard to this point, but they are cleared up by the lateral position.

Where pyelography shows the presence of a stone in the kidney, the localization of the stone to the calyx in which it lies, or to the pelvis, is accurate and of much assistance to the surgeon when the stone is small and its removal is proposed. But here again there is a source of fallacy, for in the experience of the writers a small stone demonstrated by pyelography to lie in a calyx at the upper pole, may be found at operation to lie in a calyx at the lower pole, or in the pelvis. Too much reliance, therefore, cannot be placed upon

this form of localization as an aid to operation.

With an opaque catheter in the ureter and the renal pelvis filled with opaque material, the shadows thrown by calcified glands are conclusively shown to lie extra-renal, and where a single shadow is present, there is no difficulty in demonstrating that it is outside the ureter.

LATERAL RADIOGRAPHY AND PYELOGRAPHY

In lateral radiography with the kidney in its normal position, and where no great enlargement of the organ is present, a kidney stone will throw a shadow on that of the body of the second lumbar vertebra. A stone occupying the extreme limit of a calyx may throw a shadow which appears behind the body of the vertebra, but this is a rare finding, and will not give rise to confusion with any other shadow. The two conditions which may cause confusion with the shadow of a kidney stone, are gall-stones and calcified abdominal glands. The gall-stone shadow lies well in front of the shadow of the vertebral bodies, usually at the level of the upper three lumbar vertebrae, but sometimes as low as the fourth lumbar vertebra.

The shadows of calcified abdominal glands may lie in the kidney region, but usually they are lower down, and in the lateral view in front of the bodies of the third or fourth lumbar vertebrae. An example of such a condition was a lady who had, a few years previously, been operated upon for stone in the right kidney. The kidney and stone had been removed. Recently she experienced symptoms similar to those previously complained of, and a doubt existed as to their cause. A negative in the anteroposterior position showed a large shadow in the renal region, situated near the position of the lower pole of the left kidney, and lying in front of the ureter. A lateral roentgenogram demonstrated the shadow some distance in front of the ureter, and therefore not causing pressure symptoms.

In cases where any doubt exists as to whether a shadow or group of shadows is thrown by renal calculi or by calcified glands, anteroposterior and lateral pyelography should be carried out. The exact relation of the renal pelvis and of the ureter to the doubtful shadows is demonstrated clearly.

Objections have been raised to the use of the lateral method. It is difficult to get satisfactory negatives in stout patients. This is a matter of technique and applies to the anteroposterior as well as to the lateral position. An improving technique will show an increasing number of successful lateral radiograms in stout patients. It is stated that it is not possible to demonstrate gall-stones in the lateral position. This is not the case. It is not possible to show all the gall-stones in either position, but a gall-stone, which in the anteroposterior or posteroanterior position shows a definite shadow, should be almost as readily shown when a good lateral negative is produced. Most renal stones will show in the lateral position through the shadow of the spine. Should a shadow which is very distinct in either or both of the first two positions, not appear in front of the spine in the lateral, we may be reasonably certain it is not a gall-stone. It may have been lost in the shadow of the vertebral bodies, but if it occupies that position, it is not a gall-stone. An exception which might cause some difficulty would be a small gall-stone in the common duct close to the duodenum. The shadow might be near enough to the spine to suggest the possibility of a kidney stone. Pyelography is of great value in such a case. The clinical symptoms may decide the diagnosis apart from the *x*-ray examination, but exploration may be necessary to settle the diagnosis. A practical point of some importance in the technique of gall-bladder and kidney radiography is to realize the type of negative at which it is desirable to aim. The earlier kidney radiography led to the production of a number of first-class negatives of that region, and no better technical work has been produced in recent years. The detail of bone is remarkably good in these negatives, the aim of most workers being to produce a high-class negative with strong contrasts in the bones. This type of negative is quite good for the demonstration of stones of considerable density and of fairly large size. The smaller and less dense stones are likely to be missed,

while gall-stones are rarely shown in this type of negative. It is considered better in later work to aim at a negative which will give good detail in the softer parts, the bone detail being a secondary consideration. In development it is well not to carry the process too far, as a fairly thin negative is required.

ACUTE MEDIASTINAL ABSCESS: REPORT OF FOUR CASES IN CHILDREN*

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A HASTY and more or less superficial search of the literature has revealed very few references to the subject of mediastinal abscess in the general medical literature and practically nothing on the roentgenological aspects of the condition. Where the subject is mentioned it is usually the chronic, so-called "cold abscesses," associated with tuberculosis of the spine, which are referred to.

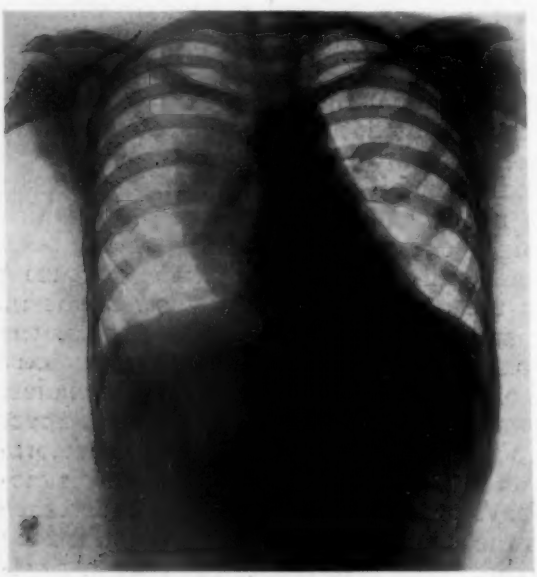

FIG. 1. Case I.

That the condition is not a common one is shown by the fact that there were only 2 cases in more than 600 children whose chests were examined in the *x*-ray department of Children's Hospital in the last two years, and only 2 have been found in the University of California Hospital.

In view of these facts I have thought it worth while to put these cases on record.

CASE I. Female, aged eight years. Entered the University of California Hospital June 3, 1919, with a diagnosis of bronchopneumonia. This condition gradually cleared up and the temperature dropped to normal. After a few days the temperature came up again with a septic swing. The child was sent to the roentgen-ray department on June 16th for examination for a suspected empyema. The roentgenogram (Fig. 1) showed a shadow of increased density on the right, continuous with the posterior mediastinum and extending outward into the right chest. The outer border was sharply outlined but it faded out and became indistinct above. These findings remained constant for about three weeks but the child did not improve. Accordingly, on July 10th the tenth rib on the right was resected close to the spine, and the abscess found and drained. The temperature immediately dropped to normal and remained there for several days. However, on July 18th the temperature rose again, due to a recurrence of the bronchopneumonia, and the child died July 23rd. No post-mortem was obtained.

CASE II. Female, aged eleven years. Was admitted to Children's Hospital Jan. 10, 1922, with an entrance diagnosis of empyema. There was a history of lobar pneumonia in the right lower and left upper lobes beginning two weeks previous to entry. Five days previous to entry the temperature dropped to normal and then came up again with a septic swing. Roentgen examination on Jan. 11th (Fig. 2) showed an empyema on the right with a second shadow projecting beyond the right border of the sternum and with a well-defined right border which was visible

* Paper submitted leading to membership in THE AMERICAN ROENTGEN RAY SOCIETY, 1922.

through the empyema shadow and was somewhat nodular in outline. This was

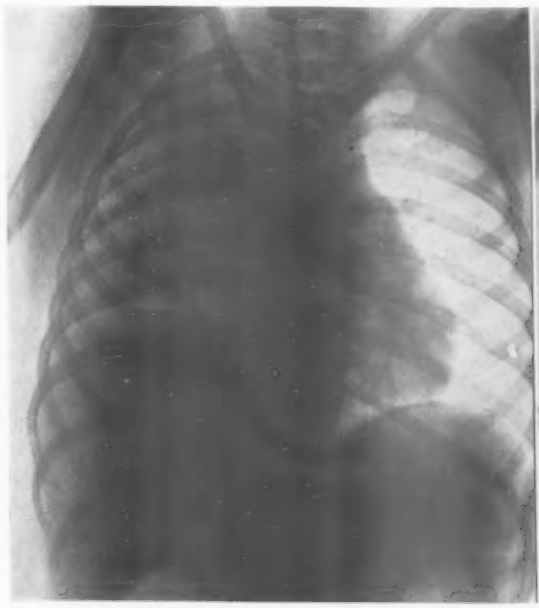

FIG. 2. Case II before drainage of pleural sac.

FIG. 3. Case II after drainage, showing separate substernal accumulation.

thought to be a mass of substernal glands. A rib was resected and the empyema drained on Jan. 12th., after which the temperature dropped almost to normal for two days and then came up again. The child did very badly for several days in spite of good drainage from the wound. A second *x*-ray examination (Fig. 3) showed good drainage of the empyema cavity, but the substernal shadow was still present. On the morning of Feb. 7th, while the nurse was doing the dressing, the child coughed and there was a sudden profuse discharge of pus from the wound. A roentgenogram was made immediately and the substernal shadow was found to have diminished markedly in size. There was profuse drainage for several days, after which the temperature returned to normal and drainage gradually ceased. Convalescence was rapid, and a roentgenogram taken March 17th (Fig. 4) showed the chest clear except for some thickening of the pleura.

CASE III. Male, aged eight months. Was admitted to Children's Hospital Feb. 19, 1922, with a history of an acute respiratory tract infection of two weeks' duration which had been treated by a Chinese doctor and which had suddenly become worse. The entrance diagnosis was bronchopneumonia. A roentgenogram taken a few days after entry showed a bronchopneumonia and a sharply-outlined shadow apparently continuous with the posterior mediastinum and extending into the right chest in the region of the right upper lobe.

FIG. 4. Case II following recovery.

This plate has unfortunately been lost or misplaced. The shadow gradually increased in size until it reached the dimensions shown in Figure 5. On March 9th a thoracentesis was done posteriorly at the level of the fourth dorsal vertebra as close to the spine as possible, and pus was obtained. This was repeated several times in the next few days, and pus obtained each time. On March 26th a large trochar was passed in and a great amount of purulent fluid withdrawn. The temperature rapidly dropped to normal after this and convalescence was rapid and complete.

FIG. 5. Case III.

CASE IV. Female, aged sixteen. Entered Hahnemann Hospital March 2, 1922. There was a history of a severe sore throat complicated by an edema of the larynx requiring an emergency tracheotomy ten days previous to admission. The tracheotomy tube had slipped out the next day, allowing some of the purulent tracheal secretion to escape into the soft tissues. The temperature and blood count soon began to rise and the patient was brought to the hospital with a diagnosis of suspected mediastinal abscess. A roentgenogram taken March 3rd (Fig. 6) shows a well-defined shadow in the right chest apparently continuous with the mediastinum which was interpreted as a mediastinal abscess. No attempt was made to drain the abscess and treatment was purely symptomatic. The temperature stayed up for several days and then gradually fell to normal. The patient was discharged as well March 30th, but there was no change in the roentgen appearance of the shadow.

FIG. 6. Case IV.

EXAMINATION OF THE POSTERIOR MEDIASTINAL GLANDS IN THE EARLY RECOGNITION OF PULMONARY TUBERCULOSIS*

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THE recognition of early pulmonary tuberculosis, notwithstanding great advance in our knowledge of the subject, is still frequently most difficult, especially in those cases in which the disease does not manifest itself by any physical or conclusive signs in the chest. It has, therefore, been my endeavor in the past four years to find some roentgenological sign by which the early and obscure manifestations of the disease may be recognized before the lung itself shows gross morphological change.

If it be possible to make a diagnosis of pulmonary tuberculosis, based on recognized evidence of changes other than lesions of the lungs themselves, it is obvious that the chances for the patient's recovery will be greatly enhanced. It has, at times, been my privilege to give the physician such evidence, permitting him to correlate the early clinical manifestations of pulmonary tuberculosis with demonstratable lesions outside the lungs. This I believe can be accomplished by examination of the glands in the posterior mediastinum in all chest examinations when pulmonary tuberculosis is suspected.

The lymphatic vessels of the lungs consist of two sets, the superficial and the deep. The former are placed beneath the pleura and cover the outer surface of the lung. The latter accompany the blood-vessels and run along the bronchi, where they terminate at the root of the lung or hilus region. These glands are intimately connected with those of the posterior mediastinum. The lymphatic vessels of the esophagus form a plexus around that tube, traverse the glands in the posterior mediastinum, and after communicating with the pulmonary glands and vessels at the root of the lung, terminate in the thoracic duct. The posterior mediastinal glands are situated in the areolar tissue of the posterior mediastinum, forming a continuous chain by the side of the aorta and the esophagus, communicating on each side with the intercostals below, and with the lumbar glands and the deep cervical above.

Therefore, this brief study of the lymphatics of the posterior mediastinum and their connections permits one to note the possibility of infection from the nasopharnyx and the buccal cavity taking place directly to the hilices of the lungs through these channels. These premises have led me to make a complete roentgenological investigation of the glands of the posterior mediastinum in both disease and health. Special attention has been paid to changes in the posterior mediastinal glands in pulmonary tuberculosis. This study has aided me in arriving at some very definite roentgenological conclusions.

I shall not attempt to describe any of the experimental work that has been done in the way of determining the portals of infection in pulmonary tuberculosis, as space in this modest monograph does not permit. However, I will say that some authors, notably some of the French school, believe that it is impossible to infect the lungs of animals directly by the respiratory channels, and that tuberculous infection takes place by other channels than those of the respiratory passages. These premises are possible when a thorough consideration of the anatomy of the lymphatics connecting the buccal cavity with the hilus of the lungs is made.

Technique. The patient stands at an angle of 45 degrees, with the left scapula resting against the fluoroscope and the right shoulder touching the screen. This position must be varied in order that the maximum amount of space between the heart and the vertebral column be obtained in the visualization of the postcardiac space. This is done by rotating the patient

* Paper submitted with application for membership in THE AMERICAN ROENTGEN RAY SOCIETY, 1922.

backward and forward until the desired angle is obtained. The postcardiac space is first visualized with the open diaphragm and a quick survey of the entire field is made. If considerable infiltration has taken place, the whole field is darkened and very little fluorescence takes place in this portion of the screen. If the infiltration is fairly heavy, a distinct chain of glands is seen extending from the upper portion of the space to the hilus region, and in some cases to the inferior portion of the space. When the infiltration is slight, thin narrow lines are seen extending downward throughout the space like strands of rope. In some instances infiltration is limited to the glands entering the hilices of the lungs, the glands in the upper and lower portions not being visualized. It is also true that many normal cases show infiltration of the glands in the postcardiac space, but when these are present there is usually a history of some recent or previous lung involvement. It has been my experience to note that many cases of recovered tuberculosis show involvement of the posterior mediastinal glands; but instead of the general involvement obstructing the greater portion of the space, as seen in active cases, these cases show distinct rounded shadows forming a chain giving the appearance of scattered shot of different calibrations.

Advanced cases of pulmonary tuberculosis usually, but not always, show involvement of the postcardiac glands. In the fulminating type I have seen the postcardiac space present almost a clear appearance. In these cases the glands are undoubtedly offering very little resistance to the advance of the disease. In the chronic fibroid type I have seen the postcardiac space filled in its entirety, due undoubtedly to a great effort of the organism in its endeavor to block the advancing infection.

My first attention to the value of the examination of the postcardiac space in the early diagnosis of pulmonary tuberculosis was made while examining a young nurse in training, who had been brought to the radiological department of the San Francisco County Hospital for special study of the lung fields. It appeared that she had complained for three months previous, of a slight cough attended by a rise in the evening temperature. As this occurred during the epidemic of influenza which visited San Francisco about that time, it was first regarded as a post-influenzal complication. Repeated physical examinations had been made, but nothing had been determined to account for her subjective symptoms. At first there was no loss of weight and the patient looked in the pink of condition.

In fluoroscoping the case I did not notice any pathological change in the lung fields themselves, but in turning the patient from the anteroposterior position to the posteroanterior position, I visualized, much to my astonishment, a large clump of glands in the posterior mediastinum, in its upper portion, very heavily infiltrated. Those in the inferior portion of the space were less infiltrated than those above. This heavy thickening was so marked that I was at first tempted to consider a possibility of Hodgkin's disease. However, after careful study of the case I made a report stating that I considered that there was a tuberculous infection of the glands in the posterior mediastinum which had, as yet, not broken into the lung itself.

Subsequent to this examination the clinical picture changed in some respects. The patient's temperature constantly remained above normal and medication apparently had no favorable effect whatever. I advised that several series of radiations be given over the posterior mediastinal glands. This was done, and after several treatments with heavy penetrating rays, the patient's temperature returned to normal. The treatments were unfortunately discontinued as the patient was possessed with an abnormal fear of an *x*-ray burn and absolutely refused to submit to any further radiation.

I lost track of the case for several months, as the patient was sent to a sanitarium. About six months later I saw some roentgenograms, of the case made by another roentgenologist. In these studies definite lung changes were shown. A positive diagnosis of pulmonary tuberculosis was made about that time and she

is now in a tuberculosis sanitarium in Colorado Springs.

In reviewing the case from the description given above and in the light of subsequent experience, it is clear to me that a provisional diagnosis of pulmonary tuberculosis would have been warranted on account of the mediastinal changes, having a definite connection with the history and physical findings of the case.

SUMMARY

As a negative sign, the non-involvement of the glands in the posterior mediastinum possesses great value in eliminating pulmonary tuberculosis where this disease is suspected.

I have examined the glands situated in the posterior mediastinum in about 4,000 cases, and have never failed to find them involved where a frank pulmonary tuberculosis was manifest.

In many cases of early pulmonary tuberculosis where practically no signs were present in roentgenograms made of the chest (and where the fluoroscope showed involvement of the posterior mediastinal glands and where there was a suspicious anamnesis), patients have been greatly benefited by being placed on treatment for suspected pulmonary tuberculosis.

OSTEOCHONDRITIS DEFORMANS JUVENILIS*

BY B. R. KIRKLIN, M.D.

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IN June, 1909, Dr. Arthur T. Legg, at the meeting of the American Orthopedic Association, reported 5 cases of "An Obscure Affection of the Hip-Joint." This paper was published in the *Boston Medical and Surgical Journal* in February, 1910, and apparently is the first contribution on this subject. In July, 1910, Dr. Jaques Calvé selected from some 500 cases of "Coxalgie" 10 cases presenting a form of "Pseudo-coxalgie." It was his opinion that this small group of cases presented differential points sufficiently characteristic to warrant a special classification and discussion. His cases were apparently identical with Legg's cases. Three years later, in 1913, Dr. George Perthes contributed the first intensive publication on this subject under the heading, "Osteochondritis Deformans Juvenalis," in which he made the first contribution to the literature of a histologic examination in a case of osteochondritis deformans juvenalis. In spite of these undisputed facts this affection is more generally known as "Perthes' disease," and from this time on appeared in the German literature under the title of "Perthes' disease." Prior to 1914, Legg's original and subsequent contributions were overlooked or ignored in the various German monographs on the subject, although, as pointed out by Sundt, references to Legg's original article appeared in three German periodicals in 1910 and 1911.

FIG. 1. Case I. Typical case.

The literature on this subject since 1915 has become voluminous and more than 350 cases have been reported. The names of Legg, Calvé and Perthes, however, must remain conspicuously associated with the original recognition of this condition.

* Read at the Fourth Annual Meeting of the Central Section of THE AMERICAN ROENTGEN RAY SOCIETY, Louisville, Ky., Feb. 24, 1923.

From a number of clinics a retrospective analysis of a large series of cases, formerly diagnosed and treated as tuberculous disease of the hip-joint, demonstrated the fact that the roentgenograms of many of these cases showed the appearances characteristic of this condition, and I believe that most of the active cases which I personally have seen have been referred with a clinical diagnosis of tuberculous hip-joint disease.

FIG. 2a and b. Case II. Roentgenograms made one year apart, showing gradual progress of disease.

FIG. 2c. Case II. Roentgenogram made one year after Figure 2b.

This condition is met with principally in children in the first decade of life, is more common in boys, and its inception is often associated in the minds of the parents with some recent injury in the region of the hip. In its early stages it closely resembles tuberculosis of the hip, due to its gradual onset without early marked symptoms, but in its later stages shows a vast difference. A slight limp, occurring early and persisting late, becoming more and more intermittent, and accompanied by slight or no pain, is the obvious symptom. The limp, according to McChesney, may last from two to four years and then lessen, in spite of greater destruction of the epiphysis. Limitation of abduction persists much as the limp does. Slight shortening and atrophy are only occasional symptoms. Pain is almost a negligible factor.

FIG. 3a. Case III. Shows more marked destruction of epiphysis.

The affection usually terminates in recovery with a remodeled joint but with excellent use. The articular surface of the femoral head is extended toward the

trochanter and is somewhat flat, but becomes smooth, and pain, if present, disappears and only the slight restriction of motion and the changes shown by the roentgenogram remain to identify the process. Ankylosis and fixed flexion of abduction, which are so common after tuberculous hip-joint disease, do not occur.

The roentgenogram, when once seen, is very typical, so much so that most writers on the subject assert that a roentgen-ray examination alone is sufficient for the diagnosis.

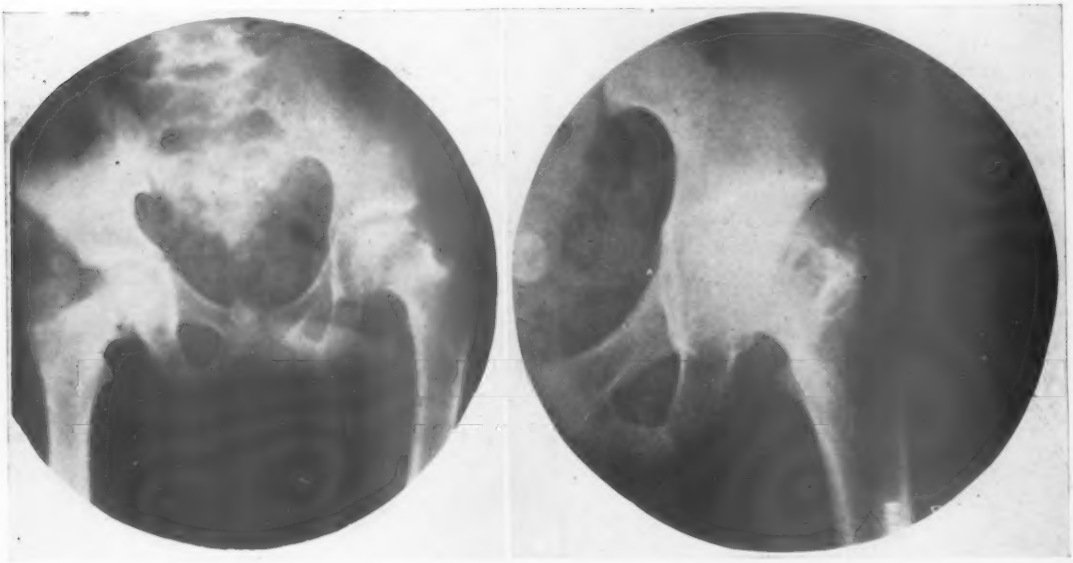

FIG. 3b and c. Case III. Note that a and b were made one year apart, while c was made two years after b.

The flattening or crushing of the epiphysis and broadening of the neck of the femur are the salient features. The flattening of the epiphysis is progressive, being slight at first, and increasing till the epiphysis loses its rounded outline and is reduced to a flattened plate or disc, often divided into

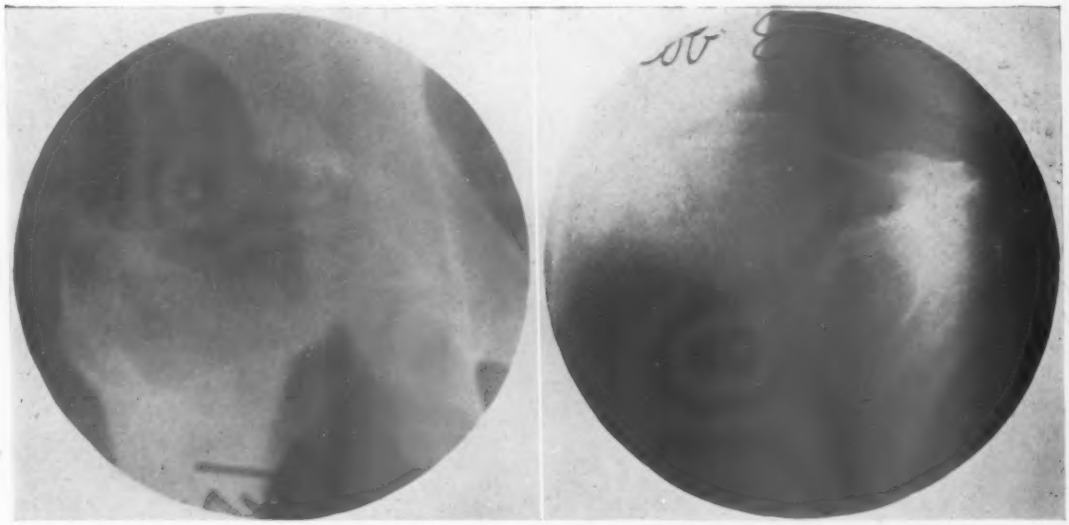

FIG. 4. Case IV. Bilateral healed osteochondritis deformans juvenilis. Served in world war.

several segments. Later these appear to fuse, and the whole is finally united to the diaphysis. There is no hazing or clouding of the joint.

The upper part of the femoral neck is seen to broaden, and becomes, as it were, rounded off. Coincident with this broadening there is a gradual shortening of the neck as a whole and an increased density (eburnation). At first sight the angle of inclination between the neck and shaft of the femur would appear to be lessened, with the development of consequent coxa vara deformity. This was originally emphasized by Calvé, and in other earlier contributions in the literature was regarded as indicating true coxa vara. But it is now generally conceded that there is no actual bending of the neck, but that the depression is apparent and not real.

FIG. 5. Case V. Healed osteochondritis deformans juvenilis. Served in world war. Note the almost perfect articulating surfaces.

Most of the writers on this subject tend to regard the acetabular changes as relatively inconspicuous, unimportant or actually non-existent. Perthes states that the acetabulum shows no deformation except in very advanced cases. Sundt, however, writes that in the later stages the acetabulum is normal. Swartz describes late changes which he classifies as hypertrophic, and secondary to changes in the head. Platt declares that osseous changes in the acetabulum can be seen at every stage of the disease and that they should be considered partly as the adaptation of the cavity to the altered line of pressure through the deformed head, and partly as of the same nature as the transformation undergone by the epiphyseal nucleus, and thus truly specific.

The roentgenological appearances of the various other hip-joint affections are so typical that I do not think it necessary to take the time to go into the differential diagnosis of this condition.

I am indebted to Dr. C. A. Sellars, who referred Case III to us and who furnished Figure 3c.

BIBLIOGRAPHY

BAETJER. Differential diagnosis by *x*-ray between rickets, syphilis, scurvy and condition known as Perthes' disease. *Med. Clin. N. America*, 1919, ii, 1703.

BRANDES and MAU. Osteochondritis deformans juvenalis and tuberculin reaction. *Méd. Klin.*, 1921, xvii, 715.

CALVÉ. Difficultés du diagnostic de la coxalgie au début. *Presse méd.*, February 17, 1909. Sur une forme particulière de pseudocoxalgie. *Rev. de chir.*, July 10, 1910.

DELITALA. A typical disease of the femur. *Am. J. Orthop. Surg.*, April, 1915.

FENNER. Juvenile deforming osteochondritis with report of cases. *N. Orl. M. & S. J.*, 1922, lxxiv, 659.

FREIBERG. The evolution of osteochondritis deformans coxae juvenilis. *J. Am. M. Assn.*, 1916, lxvii, 658.

LEGG. An obscure affection of the hip-joint. *Boston M. & S. J.*, February 17, 1910; *Tr. Am. Orthop. Assn.*, June, 1909.

LEGG. Osteochondral trophopathy of the hip-joint. *Surg., Gynec. & Obst.*, 1916, xxii, 307.

MCCHESNEY. Juvenile deforming osteochondritis of the hip. *J. Am. M. Assn.*, 1915, lxv, 1637.

PERTHES. Osteochondritis deformans juvenalis. *Arch. f. klin. Chir.*, 1913, p. 779. Arthritis deformans juvenalis. *Deutsche Ztschr. f. Chir.*, 1910, cvii, 111.

PLATT. Osteochondritis deformans juvenalis coxæ (quiet hip disease): a clinical and radiographic study. *Brit. J. Surg.*, 1922, ix, 366.

SCHWARZ. *Beitr. z. klin. Chir.*, 1913.

SUNDT. Calvé-Legg-Perthes diseases of the hip. *Zentralbl. f. Chir.*, 1920, xlvii, 538.

TAYLOR and FRIEDER. Quiet hip disease. *Surg., Gynec. & Obst.*, 1916, xxii, 158.

WALDENSTROM. Tuberculous foci of the upper part of the neck of the femur. *Ztschr. f. orthop. Chir.*, 1909, xxiv, 3. Tuberculosis des collum femoris in Kindesalter. Stockholm, 1910.

DISCUSSION

DR. NICHOLS. It seems to me that this is a very important subject from the roentgenologist's standpoint, for with early diagnosis the treatment of this disease is very satisfactory. If these children are properly treated they recover, and if not, they go on to the deformi-

ties which we see in adults, so that it is important that we as roentgenologists recognize this disease early in order that these patients may receive proper treatment.

DR. POTTER. Dr. Kirklin's paper is very interesting, especially from one standpoint: What finally becomes of the head of the femur? Dr. Kirklin showed slides on one case which covered a period of four years, and there was very little change in the appearance of the head. I have seen one or two cases where, in a similar time, a great deal of absorption of the head took place. In some of the adult cases the maturely-formed head of the bone is so short and flat that a great deal of it must have been absorbed before maturity. I believe if this subject were followed up systematically it would be found that many cases show a complete absorption of the head before the other epiphyses had united and, on the other hand, I believe a certain percentage of the head would be left and unite in the regular way to the shaft.

DR. KIRKLIN (closing discussion). In answer to Dr. Potter, I think these cases, especially cases II and III, are splendid ones for careful follow-up study in order to determine what happens to the epiphysis. You will remember that in each of these 2 cases, we had a yearly roentgenogram and I have already requested these cases either to return to my office once a year, or to have roentgenograms made elsewhere and sent to me that often. In this way we will be able to follow these 2 cases, providing nothing happens, for as many years as we like. And I shall be very glad to report them at some future date.

It has seemed to me that one of the earliest roentgenological findings that we see is probably the thickening of the neck of the femur.

TYPICAL DISEASE OF THE SECOND METATARSOPHALANGEAL JOINT

BY PROF. DR. ALBAN KOHLER

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THE second metatarsophalangeal joint is subject to a peculiar disease, to which I called attention in 1915 in the second edition of my book, "Grenzendes Normalen und Anfänge des Pathologischen," in the following words: "One sometimes finds in the roentgenogram at the site complained of, a joint-space of double breadth, where the second or third metatarsals, or both, articulate with the toes. There is a definite proximal displacement of the end of the metatarsal involved. There is as yet no description of this finding in the literature. The author has seen altogether 4 or 5 cases. It is obvious that the finding is pathologic, but the author is not aware of the cause or the nature of the disease."

I described my cases more minutely in 1920 at the eleventh congress of the German Roentgen Ray Society.[1] Meanwhile a number of further contributions have appeared, so that up to the present a total of about 75 cases have been recognized.

The disease involves the articular surface of the base of the proximal phalanx of the second toe (seldom the third or both together); the metatarsophalangeal joint, the articular surface of the head of the metatarsal, the head itself, and the whole distal half of the metatarsal. These structures are altered in the following manner:

1. The shadow of the articular surface of the proximal phalanx in plantar-dorsal exposures loses its perfectly circular form, and becomes irregular, often approaching an S-shape.

2. The joint-space in almost all cases is broader than normal. This is all the more remarkable because in all arthritides, aside from those with effusion, there is never a broadening, but in the presence of changes as great as in this condition, an actual narrowing of the joint-space, as if the articular cartilage had been ground away or crumpled up.

3. The joint-space is not only broadened, but the broadening is strikingly irregular, so that the fibular half of the space is often double that of the tibial half.

4. The articular surface of the head of the metatarsus loses its normal roundness; in early cases it is only more or less flat-

[1] See the Transactions of this Congress. An abridged account appeared in *Münchner med. Wchnschr.*, 1920, No. 45.

tened, but in old cases it shows quite irregular knobs and defects.

5. In advanced cases of long standing, on the fibular aspect of the joint, and even deep in the soft parts, are from one to several shadows indicating a density equivalent to bone; these shadows vary from the size of the head of a pin to the size of a lentil, and resemble the calcified plaques in the capsules of the large joints, but are always circular.

FIG. 1. A case in the early stage of the disease.

6. The head of the metatarsal is undoubtedly shortened, not *in toto*, but in its distal third, as if the cap had been driven in. This naturally makes the whole metatarsal somewhat shorter. So far, the process could be compared, though the resemblance is a remote one, to a severe monarthritis; but there is still to be considered one important feature:

7. In all frank cases the whole distal half of the metatarsal is more or less altered, and is definitely increased in circumference, so that there is no longer a constriction at the site of the neck. Thus the distal half is often like the proximal in point of size and shape. The thickening is not confined to the medulla, but also involves the cortex, which however, thins out normally toward the proximal end of the bone. What is particularly striking, in contradistinction to the changes of osteomyelitis and spina ventosa, which produce roentgenograms remotely resembling this condition, is the increase in the size of the bone distally. Also the spongiosa, as far as the tip of the bone, appears regular and of well-ordered design.

The number of cases reported up to the present—that is, in the last two and a half years, indicates that the disease is not especially rare; in any case, it is encountered more frequently than the disease that is peculiar to the navicular bone. In 9 cases out of 10, the second metatarsal is involved; one time in 10, the third alone or together with the second. In at least 2 cases, both feet were involved. The age of the patients ranged from ten to forty-eight years, but it is to be noted that in persons beyond the fifteenth to eighteenth year, the disease was very probably not of recent development, but originated in the growth-period and was accompanied by associated changes in the sense of arthritis deformans. Two thirds of the patients were from ten to eighteen years old. The disease is four times as common in the female sex as in the male. In two thirds of the cases the right foot was involved.

The patient's complaint is of pain in the region of the joint in question, especially on weight-bearing and eversion of the foot. The disturbances of locomotion are usually variable and moderate; but oftentimes the patient spares the limb, or is even lame. At all events, indulgence in sports, etc., is limited or even impossible.

Objective Manifestations. Usually a slight swelling of the soft parts on the dorsum, especially in the vicinity of the lesion, with tenderness on pressure on the dorsum or on the sole or both. Pain on motion is uncommon.

At least two authors found in their cases a bending of the epiphysis toward the dorsum of the foot. This finding is not confirmed by other authors, even by those who have sought especially for it. However,

it is advisable in every case to make a roentgenogram of the profile of the foot, in spite of the disturbing shadows of the metatarsals, especially the thick first one. Further, both feet should always be examined.

Differential Diagnosis. As in case of the disease peculiar to the navicular bone so here: when one has once seen the roentgenogram, it is not easily forgotten, at least in the cases occurring in the *growth-period* (see above). Consequently, the diagnosis is very easy. Furthermore, the very old cases with considerable malformation of the articular ends of the bones are very easily distinguished from the primary chronic (mon-) arthritis; the author can perhaps best testify to this, for perhaps most of the arthritis cases in Wiesbaden have come under his observation in roentgenograms. In no case should be overlooked the thickening of the distal half of the involved metatarsal, which unqualifiedly belongs to the picture of the disease. Three characteristic roentgenograms are reproduced.

Pathology. At least eight microscopic examinations have been reported, which are more or less detailed. There were found at times necrosis, at times fibrous marrow, at times tissue resembling granulation tissue, thickened cortex, well-preserved cartilage. Fromme found subchondral callus-like tissue with fibrillary connective tissue, fibrous cartilage, hyaline cartilage and osteoid substance; Aschausen observed a great subchondral focus with bone- and marrow-necrosis and calcification, surrounded by a resorption zone with thick leukocyte-free connective tissue, and this surrounded in turn by a bone of reaction; the cartilage itself preserved and also thickened, somewhat necrotic in its deepest part; and finally, villous hyperplasia of the synovialis, and lipping as in arthritis deformans. There were found no signs of rickets, tuberculosis, syphilis, osteomyelitis or the like. A third account may be mentioned here, Professor Goldschmidt's report in the article by Cahen-Brach: "Horizontal sections were made through the capitulum of the second left metatarsal. The region of the bone limited by the articular cartilage and the epiphyseal line showed a profound change: in the spongiosa was found a focus, rather rounded in the section, which reached in a stellate fashion to the boundaries just mentioned. In this focus the bony trabeculae were either absent or represented only by fragments. In their place was a connective-tissue focus, fairly rich in cells, embedding fairly numerous small blood-vessels. At the edges of this focus the connective tissue extended, without any sharp border,

FIG. 2. Another case, more advanced.

into the marrow, which was partly a definite fibrous marrow and partly only remarkable because it was rich in connective tissue. Beneath the articular cartilage the bony trabeculae showed no great changes, though no special stains for bone were used. The changes go with the connective tissue described. On the other hand, in the immediate vicinity of this focus there was a zone at the epiphyseal line which one may well designate as a field of dèbris, i.e., the trabeculae lay in fragments in a space filled with necrotic masses. These masses lay directly upon the granulation- or connective-tissue; no inter-

nal structure could be recognized. Hemorrhage was not demonstrable, though there were small hemorrhages in the spongiosa on the diaphyseal side of the epiphyseal line. In neither the necrotic zone nor in the connective-tissue foci did I find profound vascular changes, particularly no thromboses. So far as the articular cartilage was examined, no changes were found. In other respects the relation between cartilage and bone was normal for the age of the (female) patient."

FIG. 3. Another case, of several years' standing, with consecutive arthritis deformans.

Etiology. About 1 patient in 10 gave a history of trauma. We need not dwell further on this point. Certainly trauma alone cannot be the cause. It is much more likely that a barely perceptible mechanical insult, perhaps repeated, is necessary to bring about the clinical manifestation. Against traumatic origin there speak further the slow beginning and the occasional bilateral occurrence of the disease, as well as the histologic and roentgen findings. The points of principal support of the arch on standing on both feet or in walking, according to the investigations of Beely, are the heel and the distal ends of the second and third metatarsals; if the foot is hanging, or if it rests only lightly on its sole, then the distal ends of the first and fifth metatarsals are supports; but if a considerable pressure is placed upon the anterior transverse arch, the arch gives, and the distal ends of the second, third and fourth metatarsals become burdened. In case of flat- or splay-foot the second assumes very much of a burden. In keeping with this, flat-foot appears in the history of many of the patients; and Sonntag found, in 12 cases minutely described, the arch to be normal in only 3, and flat- or splay-feet in 9. However, now that we have 70 cases to study, we find flat-feet in only 1 case in 5 (Cahen-Brach, l.c.). In two or three cases, going barefoot was blamed. In going barefoot one naturally loses the support of the shoe. If there be added a weakness of the connective tissue, which leads to a sinking of the anterior transverse arch, especially of the second metatarsal, the first metatarsal gives medially and when the foot is pronated the principal weight is thrown upon the second. Three cases showed a bowing of the metatarsal upward, as already mentioned. Müller says that the bone is simply reacting to mechanical insults on the same principle that it forms callus after fracture: reaction of the zone of growth; it is pathological only in that the tolerance of the bony tissue to the influences in question is disturbed. Furthermore, the fashionable women's shoes, with their high heels which throw the weight on the fore part of the foot, are responsible for splay-foot so far as etiology goes, and this is in keeping with the fact that the great majority of patients are females. Histologic as well as roentgen findings speak against an inflammatory origin of the disease. As has been already emphasized, no indications of tuberculosis, syphilis, or osteomyelitis were found. (It should be noted, however, that Alberti was able to demonstrate in 4 out of his 6 cases, tuberculosis elsewhere in the body.) Fromme defends the theory that the condition is an osteochondritis of the nature of late rickets. He regards also the Calvé-Legg-Perthes disease of the hip, Schlatter's

disease of the tibial protuberance, and the navicular disease which I have described, all as manifestations of the same thing. The thickened and softened cartilage of rickets or late rickets is especially susceptible to traumatic injury. The theory has much in its favor, but in almost all of the patients in question, there were no manifestations whatever of rickets. Yet on the other hand, rachitis tarda is much more frequent than generally appreciated, and clinical signs may be absent. As for this being an inanition-osteopathy, most of the cases were among well-nourished persons. Likewise for its being a deficiency disease. Of the few microscopic studies, there are some descriptions (Aschausen, Kappis, Cahen-Bruck, Herzog, Sonntag) of most peculiar findings in fair agreement, in the form of wedge-shaped necroses of the epiphyses from interruption of nutrition. In 1905 König emphasized, in relation to operative cases of osteochondritis ossificans, that in addition to trauma there must be some other cause operating in an entirely unknown manner, to explain the formation of a sequestrum in a joint lined with cartilage. Thus it is conceived that the cuneiform necrosis of the epiphysis is from embolic-mycotic occlusion of the epiphyseal end-arteries, the mechanical occlusion being the principal consideration. Infection has little or nothing to do with it. However, whether necroses can arise in bones from arterial occlusion has been combated by pathologists (Schmidt). Quite recently Heitzmann and Engel have published microscopic findings to prove the similarity of Perthes' disease and the disease of the metatarsal. Further, Klett believes that he has found histologic evidence of osteitis fibrosa in two of his cases, and is of the opinion that it is concerned in most of the cases if not in all. It is certain that the pathologic-anatomical conception of osteitis fibrosa is still very indefinitely limited.

To sum up: There are anatomic-physiologic reasons for the localization of the disease in the second (or third) metatarsophalangeal articulation. Cases involving the first toe do not belong in this class, but in that of simple chronic arthritis. The second metatarsal is the one most exposed to weight-bearing and various insults, as is indicated by its being much the most frequently involved in the swollen foot of soldiers. This factor however is not self-sufficient for the production of the disease. There must be another pathological factor, a certain debility of the osseous system, perhaps less of an infectious nature than of a toxic, toxic-infectious, or hormonic nature, or a dyscrasia or a diathesis, through which the general resistance of the organism is lowered, to become manifest at the point of greatest strain. Or there may be a predisposition in the sense of a constitutional anomaly, perhaps analogous to the so-called stigmata of degenerations; it is not entirely disproved that phylogenetic considerations play a part.[1] Possibly slight repeated, or even more considerable over-strains lead to a form of osteochondritis-malacia. I myself in my first communication, remarked upon the similarity of the roentgen findings in comparison with osteochondritis dissecans of the knee. There can then develop—though how is still unknown—a great bony necrosis in the epiphysis, as a few scattered microscopic observations testify. In the course of years there occur alterations in the joint in the sense of an arthritis deformans, but easily to be distinguished from that condition by roentgen examination. There can also occur a bowing of the capitulum upward, as a thoroughly studied case showed, in which the microscopic examination showed only normal bone, and cartilage which was normal in the deeper layers, but stained poorly and showed some fibrous degeneration on the surface.

At the 47th Congress of the German Surgical Society, in 1923 in Berlin, no less an authority on pathology than Aschoff of Freiburg stated that our disease is probably the same process as the Calvé-Legg-Perthes disease and the disease of the os lunatum. The essential feature is a subchondral bone-necrosis, which (in the hip) leads to a re-forming of the whole head of the bone without the cartilage being destroyed. Vascular disturbances probably play a rôle in the development of the

[1] The author first called attention to this possibility at the Congress of the German Roentgen Ray Society in 1920.

disease. However, Aschausen is of the opinion that these need not always be emboli. Traumatic strains which lead to an occlusion of the vessels and other factors can cause the disease. From the pathologic standpoint the process is not the same as arthritis deformans. Aschoff does not consider as possible a direct transition from this disease into true arthritis deformans.

Treatment. Conservative treatment is to be attempted first of all. The foot should be spared as much as possible, and in case of necessity, rest in bed, poultices, baths, heat, hot air, massage, etc., are indicated, as well as supporting bandages; probably the best treatment is a well-fitting shoe with an inlay designed from a plaster-cast; in addition, constitutional treatment, good nourishment, fresh air, sun, cod-liver oil, iron, iodine, arsenic, phosphorus, calcium and organic preparations. Operation is indicated only in patients beyond the growth-period.

By and large, we may say of our disease that much still remains unexplained in its etiology and pathogenesis.

NOTE: In the *Journal of the American Medical Association* for July 21, 1923, which appeared while the foregoing article was in the hands of the printer, is an article entitled "Juvenile Deforming Metatarsophalangeal Osteochondritis—Freiberg's Infraction of the Metatarsal Head" by Dr. Philip Lewin of Chicago, who states that this condition "was first described by Freiberg of Cincinnati in 1913, in a paper read before the Southern Surgical and Gynecological Association. He saw his first case in 1903, but his paper reporting 6 cases did not appear until August, 1914." It was published in *Surgery, Gynecology and Obstetrics.* Editor.

BIBLIOGRAPHY

1. CAHEN-BRACH. The etiology of Köhler's metatarsal disease. *Arch. f. klin. Chir.*, 1923, cxxiv, No. 1. Partial bibliography.
2. FROMME. Late rickets and osteochondritis. *Verh. anat. d. deutsch. Gesellsch. f. Chir.*, 1920, p. 119; also 1921.
3. FROMME. A typical disease of the proximal articulation of the toe. *Zentralbl. f. Chir.*, 1921–22, p. 797.
4. FROMME. Köhler's disease. *Munchen. med. Wchnschr.*, 1922, No. 29, p. 1096.
5. ASCHAUSEN. The etiology of Köhler's disease. *Beitr. z. klin. Chir.*, 1922, cxxvi.
6. ALBERTI. Köhler's syndrome. La Chir. degl. organi di movimento, 1922.
7. MÜLLER. *Münchn. med. Wchnschr.*, 1922, No. 42; also, *Beitr. z. klin. Chir.*, 1922, cxxvii, No. 2.
8. SONNTAG. *Deutsche Ztschr. f. Chir.*, 1921, 163; also, *München. med. Wchnschr.*, 1922, No. 45.
9. KLETT, W. Beitrag zur Ätiologie die Köhlerschen Erkrankung der Metatarso-Phalangeal-gelenke (Tafel 36).
10. HEITZMANN and ENGEL. *Med. Klin.*, 1923.
11. SCHMIDT, M. B., in Ludwig Aschoff's textbook, cited by Cahen-Brach.

TWO CASES OF LOCALIZED METASTATIC CARCINOMA OF VERTEBRAE WITHOUT DEMONSTRABLE PRIMARY LESION*

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PRIMARY carcinoma does not occur in bones. Secondary and metastatic carcinomata, however, are among the most frequent disease conditions of the osseous system. According to von Recklinghausen the bones involved are, in order of frequency, the vertebrae, femur (proximal portion), pelvis, ribs, sternum, humerus (proximal portion), the flat, cranial bones, the bones of the leg and the bones of the forearm. Secondary tumors occur in those portions of the bones which are subjected to the greatest pressure and traction. may be divided into osteoclastic (bone-destroying) or osteoplastic (bone-forming) tumors. As a rule, bone destruction and osseous formation coexist, but one or the other may predominate and form the leading character of the tumor. Naturally bone destruction must take place to some extent; the ever-expanding new growth leads to osseous atrophy, lacunar resorption and finally to more or less disintegration. Fractures commonly result, or the diseased bones may become softened and pliable through absorption of their calcium;

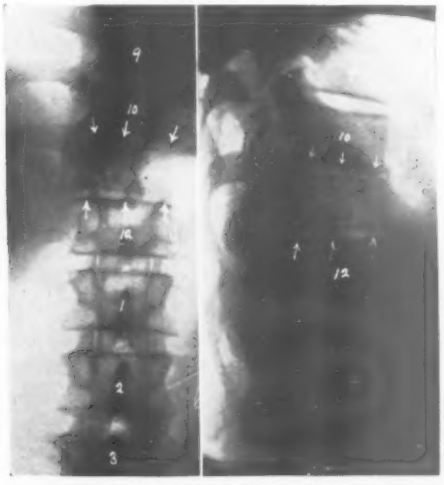

FIG. 1. FIG. 2.

FIG. 1. Anteroposterior view of lower thoracic and upper lumber vertebrae. The figures refer to the numbers of the vertebrae (9th to 12th thoracic, 1st to 3rd lumbar). The arrows point to the lesion of the 11th thoracic vertebra, which is a metastatic carcinoma (osteoclastic type). Note the destruction of bone as evidenced by the loss of outline and the compression.

FIG. 2. Lateral view of the same lesion. Compare with Figure 1. Note wedge-shape of 11th thoracic vertebra, due to compression.

FIG. 3. Anteroposterior view of 3rd to 5th lumbar vertebrae and the sacrum. The arrows point to a metastatic (osteoplastic) carcinoma. Note the increased density of the 5th lumbar vertebra and the upper portion of the sacrum.

The histologic character of the metastatic neoplasms depends more or less on the structural composition of the primary growths. The secondary tumors are sometimes well circumscribed, sometimes infiltrating. According to their behavior they

this is spoken of as carcinomatous osteomalacia. It is to be emphasized that neoplastic osteoclasis rarely involves the bone in a uniform fashion. In the roentgenogram the diseased portions are frequently irregular in outline and have a moth-eaten appearance. Conspicuous shortening of bone occurs when the destructive process is of sufficient width.

In the osteoplastic type of metastatic carcinoma much osteoid or osseous forma-

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tion occurs. The new bone formation probably takes place through stimulation or increased activity of preserved osteoblasts, the tumor acting as the irritant. It may also be that the irritation and consequent osteoblastic stimulation depend upon occlusion by tumor cells of some of the vessels of the bone. Some of the newly-formed osteoid tissue may also arise through metaplasia of the fibrous stroma of the tumor. In any case the new tissue may remain osteoid for a long period, or it may gradually become very solid, compact and osseous. The osteoplastic property of some tumors is so marked that they may transform some portions of the involved bone into an ivory-hard material. In such cases a roentgen-ray diagnosis is sometimes difficult, and the dense areas may be mistaken for non-neoplastic disease of the bones. In most cases, however, the irregular increase in density and the irregular distribution of the lesions permit a diagnosis to be made.

FIG. 4. (a) Anteroposterior view of lower thoracic vertebrae showing a metastatic carcinoma of the 9th thoracic vertebra. (b) Lateral view of same lesion showing compression from carcinomatous bone destruction.[1]

As to the frequency of cancerous metastasis to the bony structures the following figures by Kaufmann are illuminating. His data are based upon the autopsy records of the Pathological Institute in Basle. In 63 cases of carcinoma of the mammary gland, bone metastasis occurred 33 times, or in 52 per cent; and in 24 cases of prostatic cancer, 16 times. But in 309 cases of gastric carcinoma only 2.5 per cent showed bony metastasis; in 159 cases of uterine carcinoma, only 5 per cent; in 101 cases of esophageal carcinoma, 6.9 per cent, and in 57 cases of carcinoma of the rectum, 10.5 per cent. These figures show that the cancers of the mammary gland and of the prostate are particularly liable to produce bone involvement.

In the recent papers by Pfahler (1916) and by Moore (1919) further references to the literature may be found. In two cases summarized below, the vertebral column was the seat of these processes.

CASE I. Male, aged forty-nine, agent by occupation. Admitted to the Misericordia Hospital on Oct. 1, 1920, complaining of pain in the back and left side. The symptoms dated back to May, 1920, when he first experienced sharp pains in the left side, especially on arising in the morning. As the day went on the pains lessened and gradually disappeared. At first the attacks were periodic but they became much aggravated after a game of handball. Often he would awake early in the morning with sharp pains, particularly in the left lumbar region. There was much stiffness of the back and difficulty when attempting to stoop. There has been no headache, no vertigo, no cardiac symptoms. Has been badly constipated for some time; no other gastro-intestinal symptoms. Never had any serious injury. There is nothing of importance in the previous medical history; family history is negative. Laboratory examination revealed nothing of importance. A provisional diagnosis of osteoarthritis of the spine was made and the patient referred to the neurological department.

Here it was found that the patient had much difficulty and pain in making trunk movements. The 11th thoracic vertebra was tender to percussion and strong pressure. The muscular system was negative.

[1] The original plates of these photographs were not available, and the reproductions here were made with difficulty from lantern slides.

There was no impairment of the joint, postural and tactile sense. The epigastric, infraabdominal, and cremasteric reflexes could not be elicited. Both patellar reflexes were exaggerated, especially the left. No Babinski; Achilles tendon present. There was an area of distinctly diminished sensibility to pain on right side posteriorly extending from upper border of the buttock to the level of the spine of the 11th thoracic vertebra. On the left side a similar area was found, but it extended almost two inches lower. This area was just below the body of the 11th thoracic vertebra and therefore just below the 12th cord segment. The upper margins would correspond to the level of the spine of the 11th thoracic vertebra. Anteriorly there were irregular areas of hyperesthesia and hypoesthesia from below the umbilicus to above the knee, especially on the left side of the body. The level of the sensory symptoms was therefore fixed to about the 1st and 2nd lumbar cord segments or opposite the 11th thoracic vertebra and the upper margins of the 12th thoracic body.

The history, symptoms and most of the signs point to a left-sided lesion, and to involvement of the posterior roots and perhaps the lateral tracts. Since no paralysis, no bladder symptoms and no important thermic disturbance is present, the amount of cord compression cannot be very great. The character of the lesion is somewhat difficult to decide. Tuberculous caries can be ruled out because of the age and the absence of any primary focus. An intramedullary growth was excluded because the root symptoms were so pronounced at what appears to be an early stage of the disease, there were no trophic changes and the spinal tenderness was present. The pain and difficulty in moving the trunk suggested vertebral disease. Quoting Dr. Edward Strecker, who made the above examination, "In regard to carcinoma I could not bring myself to this diagnosis in the absence of an established primary lesion."

The patient was referred to the roentgenological department on Oct. 4, 1920, where examination revealed destructive disease of the 11th thoracic vertebra, which looks much like metastatic carcinoma of the osteoclastic type. Dr. G. E. Pfahler's report reads: "Total decalcification of 11th thoracic vertebra, while 10th and 12th thoracic vertebrae were perfectly healthy. There seems to be an osteoplastic process of the 5th lumbar vertebra also resembling metastatic carcinoma." These lesions are well shown in Figures 1, 2 and 3.

The primary tumor was searched for unsuccessfully. Operation was decided upon and on Nov. 5, 1920, laminectomy and resection of the posterior roots at the 11th and 12th thoracic vertebrae was performed by Dr. G. P. Muller. Portions of the friable bone were examined histologically. An infiltrating adenocarcinoma was found; the stroma of the tumor was prominent and consisted of dense fibrous tissue and spicules of newly-formed bone. The patient was treated with roentgen rays, but died on Mar. 9, 1921. No autopsy was obtained.

The clinical side of this case has been given in brief since it illustrates a very typical picture of a metastatic carcinoma, the primary focus of which could not be discovered. The pathological examination, concurred in by Drs. Smith and Lucke, confirmed the roentgenological opinion.

Case II. (From Dr. Pfahler's records.) Male, aged seventy-two. About two years ago patient was taken with pain in the right side at a point where the posterior axillary line crosses the 9th and 10th ribs. The pain was inconstant, no difficulty in eating or motion. No jaundice, no radiation of pain to shoulder. Complained also of pain in lower dorsal and upper lumbar regions. During past year suffers only when moving about or when sitting; is free from pain when reclining. Neurological examination at this time negative for osteospinal cord diseases. Urological examination revealed a slightly enlarged round, smooth, movable soft prostatic gland. On roentgenological examination a general carcinomatosis was discovered. There was total destruction of the outer portion of the 9th rib (Fig. 4) and 9th dorsal vertebra, and partial destruction of the 12th thoracic vertebra. The outer portion of the right clavicle and the glenoid cavity of the right scapula were likewise

involved, and there were metastatic nodules in the right lung.

This illustrates an extensive metastatic carcinoma of the osteoclastic type; *the primary focus of the tumor could not be discovered.*

SUMMARY

Two cases of metastatic carcinoma of the vertebral column are reported; the primary focus was not demonstrated in either case. The most prominent symptom in the two cases was pain on motion. By roentgenological examination such lesions are usually readily diagnosed, and this should always be employed.

My thanks are due to Dr. G. E. Pfahler, Dr. G. P. Muller, and Dr. E. Strecker for permission to use their data.

BIBLIOGRAPHY

1. v. Recklinghausen. Die fibrose oder deformierende ostitis, die osteomalacie u. d. osteoplastiche carcinose in ibsen gegenseitigen Beziehungen. *Festcbr. f. Virchow*, Berlin, 1891.
2. Kaufmann, Edward. Lehrbuch der Speciellen. *Pathologischen Anatomie*, Ed. 2, Berlin, 1911.
3. Pfahler, George. The roentgen diagnosis of metastatic malignant disease of bone, with special reference to the spinal column. Am. J. Roentgenol., Mar., 1917, iv, 114.
4. Moore, A. B. A roentgenologic study of metastatic malignancy of the bones. Am. J. Roentgenol., Dec., 1919, vi, 589.

HYPERNEPHROMA*

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MILWAUKEE, WISCONSIN

DURING the past year two cases of hypernephroma were observed in the roentgenological service of Mt. Sinai Hospital. Reports of similar cases have appeared recently in the *Surgical Clinic, Chicago.* The literature upon the subject is abundant, yet the writer was prompted to review it, in order to call attention to the importance and significance of chest examination in cases of hypernephroma, and to stimulate observation as to the beneficial effects from the employment of *x*-ray therapy, as has been suggested by well-known men.

An idea as to the prevalence of hypernephromata may be gathered from the following table:

Kidney Tumors (Hyman)

	Kidney Tumors	Hypernephromata	Others
Israel	126	86	40
Albrecht	32	28	4
Barney	114	43	71
Boston City and Massachusetts General Hospitals	42	33	9
Mayo Clinic, 1911	56	36	20
Mt. Sinai Hospital, N. Y. City, A. A. Berg	38	36	2
Pleschner	35	25	10
Hyman	40	28	12

In approaching this subject one is immediately impressed with the varied and complicated views held in regard to the pathology of hypernephroma. Although the theory of Grawitz, first accurately described by him in 1883,[1] regarding it as a tumor composed of aberrant adrenal tissue, has been largely accepted, there are other interesting theories that one may mention.

Grawitz called the tumor "Struma lipomatodes aberratae renis," and in 1894 Lubarsch suggested the name of hypernephroma. It is claimed, however, that the latter name was suggested by Birch-Hirschfeld, in 1896. Duffield, in 1909, applied the name of hypernephroma to any growth arising from adrenal cells, whether the growth was adenoma, carcinoma, or sarcoma.

The pathology, not only, is doubtful, but even the opinions as to what portion of the kidney is most often involved, seem to be at extremes. For example, in Murphy's case he states, "If hypernephromata arise from adrenal rests it is surprising and difficult to explain why they practically always arise in the lower two-thirds of the kidney, and almost never in the upper third, which lies so much closer to the adrenal gland."

* Paper submitted leading to membership in The American Roentgen Ray Society, 1921.

The contrary view is expressed by Hugh Hampton Young: "The occurrence of adrenal rests has been the subject of considerable study. Imbert found them in different organs in 92 out of 100 autopsies; in the kidney in 8 per cent of the cases. They are usually found in the upper pole beneath the capsule, and this is the usual site for hypernephromata."

Hyman states that the theory of location most frequently quoted as being in the upper pole has been disproved, and that it is more often found in the center or lower pole. This latter corresponds to the opinions of several surgeons personally questioned, that hypernephroma may occur almost anywhere in the kidney.

More interesting is the expression of opinion as to origin of these tumors. Stoerck, of Vienna, believes that "hypernephromata arise in the course of a chronic nephritis; that when a group of urinary tubules is destroyed, regeneration takes place from the remaining tubule stumps, and overregeneration—a well-known biologic phenomenon, seen under many different and curious conditions—sometimes occurs with adenoma formations; and from these adenomata, hypernephromata [or carcinomata, as Stoerck calls them] may develop." Stoerck's theory has obtained a great following because of the large number of accurately observed cases on which it is based, the great scientific reputation and the enormous pathologic experience of Professor Stoerck. Many of Stoerck's co-workers still adhere, however, to Grawitz's original view that these tumors start from misplaced adrenal rests. Murphy states further: "I, myself, have seen a specimen of a large hypernephroma at the upper pole of the kidney, as in the case of today where the adrenal on the same side was entirely missing. The presumption was very attractive in that case that the adrenal had been misplaced into the upper pole of the kidney by some embryonic perversity, and had furnished the starting point of the hypernephroma."

Adami believes they are of renal origin also, but that they arise from proliferating islets of nephrogenic tissue (mesoblast) derived from fetal Wolffian ducts which have never become connected with renal tubules. Therefore, Adami calls these tumors mesotheliomata instead of hypernephromata. Wilson, according to Hyman, has also advanced this theory:

"Accessory adrenals are common. They are known as adrenal rests. They are found most often in the connective tissue about the main adrenals, but also in the kidneys, right lobe of the liver, along the renal vessels, spermatic veins in the inguinal canals and in the broad ligaments."[2] In Hyman's article, previously referred to, he mentions a case of primary hypernephroma of the tongue reported by Coeneus.[3]

W. W. Keen, in 163 cases, found 157 in the kidney, 3 in the adrenal, 2 in the liver, and 1 in the uterus. Young amputated a leg for sarcoma which, upon microscopic examination, showed hypernephroma. There was no sign of kidney tumor in this case.

The period of life during which these tumors are the most prevalent appears to be from forty to sixty years. The male seems more prone to the disease than the female. Heredity appears to play no part in this condition. The literature gives no definite evidence of trauma as a causative factor, although Hyman states that "twice positively the tumor was observed after trauma."

The small hypernephromata are usually very similar in histological arrangement to adrenal tissue. The cells are seen in rows resting upon capillaries which make up the stroma. These cells are larger than adrenals and are polygonal in shape. They contain a great deal of fat, and upon chemical examination show lecithin and glycogen.

Hypernephroma may begin as a very small nodule in the kidney and gradually invade it until almost the entire kidney substance is replaced. Adjoining structures are not commonly invaded. Invasion by lymphatics is doubted; systemic invasion is usually through the blood stream. The renal veins are often invaded by the tumor. It is claimed by Murphy that operative results are much better where neither the renal veins or vena cava are invaded at time of operation. Loosened emboli are carried great distances through

the circulation. Metastases have been found in the brain, bronchi, diaphragm, heart, liver, intestines, omentum, pancreas, pleura, peritoneum, skin, uterus, urethra and various portions of the bony skeleton. There appears, however, no case on record where the ureter has been involved. This despite the fact that the tumor may grow out into the renal pelvis. (Young.)

The symptomatology of hypernephroma is as variable as its growth and pathology. The three outstanding symptoms are hematuria, pain and tumor mass. Hematuria is observed in from 50 to 70 per cent of cases. This corresponds with Bevan's observation that in about 50 per cent of cases there are no urinary findings whatever. Pain occurring before bleeding is rare. Bleeding occurs at irregular intervals. In one of Israel's cases there was hematuria for twelve years. Hematuria does not appear to be influenced by occupation or position. Frequent hemorrhages do not necessarily mean an operation as a life-saving measure.

Pain may be the first symptom, but it may be absent for a long period. A tumor mass very often reaches great size without pain. There may be only a dull ache, and at times pain may follow the course of the sacral and pelvic nerves. When the ureters are blocked by blood clots, pain becomes colicky in character, simulating renal colic.

Some of the tumors are almost impossible to elicit by palpation, particularly when they involve the upper pole of the kidneys. A palpable tumor of the flank is one of the most important symptoms. The growth may not distort the outline of the kidney. These tumors are present in a large number of cases that come to the operating table.

In Hyman's summary of these three cardinal symptoms, he places great stress on the extreme degree of variability, and hence the great difficulty in establishing an early diagnosis of hypernephroma.

Among other symptoms may be mentioned the occurrence of a right-sided varicocele, first noted by Guyon. Symptoms may also be due to compression of abdominal viscera, such as jaundice, edema and ascites. Gastric symptoms such as nausea, vomiting and hematemesis may also offer a very distressing complication.

The methods to be employed in arriving at a diagnosis, or at least offering valuable aid, are pyelography, cystoscopic examination and tests for renal function. The above constitutes the plan followed when patients finally reach the hospital, presumably for operation. It is very often at this time that the first *x*-ray examination of the chest is made. The reason for this is that by this time metastasis is expected, and the authorities seem to agree that in the presence of chest involvement operation is useless.

Bevan, Murphy, and Eisendrath speak of the importance, and emphasize the value of, roentgenograms and roentgen therapy. Eisendrath informs us that metastases into the lungs are produced very early. Murphy and Bevan have urged the employment of *x*-ray therapy in inoperable cases and as a postoperative measure, claiming beneficial results. It is well known at the present time that metastatic areas must also receive treatment as well as the original site of the lesion. Murphy is of the opinion that early application of irradiation is more beneficial than when recurrence has taken place. Patients have been kept comfortable from three to five years. This compares favorably with the results obtained by surgery.

The question as to whether or not hypernephromata are malignant tumors has not been settled. Keen says that for practical purposes a solid tumor of the kidney is malignant.

Keyes tells us that hypernephromata may be benign or malignant; the benign type has a marked tendency to become malignant. Murphy emphatically states that he considered it a malignant tumor irrespective of pathological disputes.

Garceau, according to Young, found the duration of this disease in a series of 27 cases to cover periods of from three to twelve years. In another series of 89 cases, the duration was not over a few months. In 21 cases where metastasis was present, only 4 cases lasted more than one year. He states that metastases in bones and lungs were of more importance than the actual presence of the renal tumor.

In view of the fact that this type of tumor is considered by practically all to be malignant in character, an early diagnosis is imperative. Procrastination is particularly dangerous, according to Stoerck (quoted in Hyman's article[4]) if the course of the disease can be explained by the pathological anatomy of this tumor. Stoerck gives two divisions; benign and malignant forms of the tumor. In the benign form, "the tumor is sharply encapsulated from the surrounding kidney tissue; the latter are the growths which may be present for years without causing symptoms. In the malignant type, the tumor breaks through the capsule and metastasis occurs." It is wholly desirable to interpret this condition correctly at the very earliest possible moment, or in the stage to which the term "transitional" might be applied,

FIG. 1. Key plate. Metastatic nodules in chest one year after removal of testicle for sarcoma.

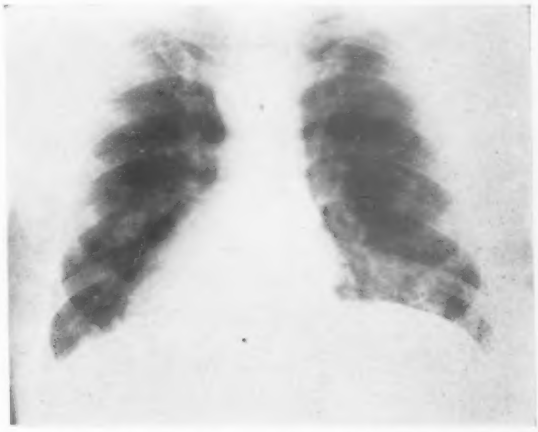

FIG. 2. Case II. The lower lung fields, bilateral, show the nodules, less dense than those found in key plate.

In 1916, Moore and Carman wrote describing the nodular form of lung metastasis, and showed five prints dealing with metastatic areas in the lung from cancer of the breast, stomach and uterus.

The writer has not been able to find any publication in which there appears an illustration showing even one phase of the metastasis of hypernephroma. It was therefore thought advisable to insert these prints.

Moore and Carman report 71 cases of lung metastasis giving 5 cases originating from the kidney, three of which were operated upon, two proving to be "hypernephroma" and one, carcinoma. In their conclusions they stated that roentgenographic examination should be made as a routine, and thus many patients saved from useless surgery.

Hyman does not concede the efficacy of radium or *x*-ray therapy as compared with nephrectomy, wherever possible. However, the early recognition of chest involvement is very important. For although the tumor of the kidney may be extirpated, the metastatic process must obviously be taken care of in some other way. It would be logical to suppose that roentgen therapy would be applied to these very cases.

Holding, in 1916, as well as others, urged the employment of roentgen therapy for the "ameliorating" effects in lung tumors. It would be of great interest to know whether this method has been satisfactorily investigated in connection with lung and bone metastases in the larger clinics of this country. The writer has not had the opportunity to employ this procedure. It is true that postoperative cases are frequently referred for treatment; but what of the inoperable cases about which a large amount of skepticism as to the efficacy of roentgen treatment still remains?

Pfahler's statement in THE AMERICAN JOURNAL OF ROENTGENOLOGY published in November, 1919, p. 576, emphasized the

importance of chest examination. The infiltrating type was described in a case of hypernephroma referred for postoperative *x*-ray therapy. Dr. Pfahler made a chest examination "where there was no thought on the part of others as to recurrence or metastasis," owing to the patient's generally good condition. He differentiated this infiltration from the infiltrating type of tuberculosis.

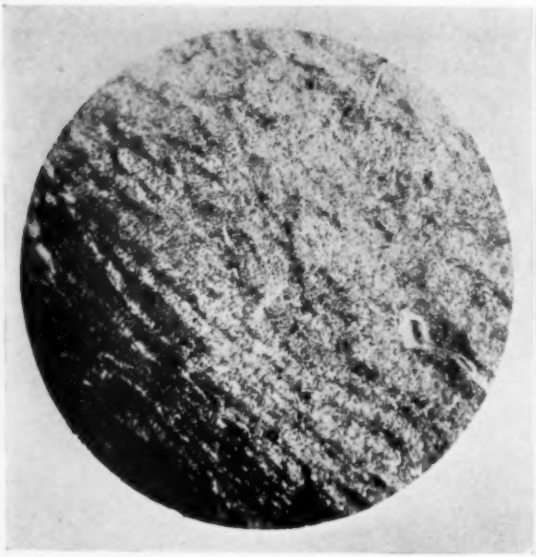

FIG. 3. Case I. Lower power. Adrenal carcinoma. Striated areas of tumor cells.

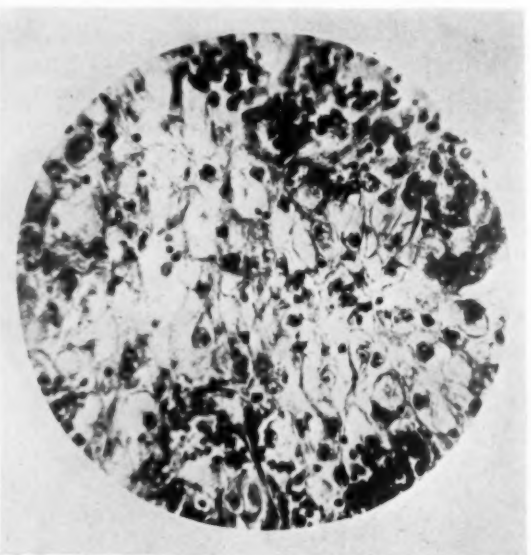

FIG. 4. Case I. High power. Adrenal carcinoma. Hyaline cells.

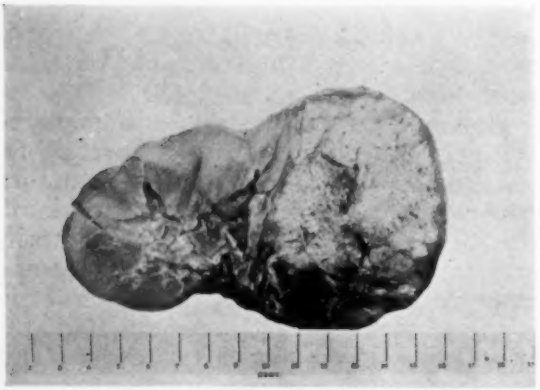

FIG. 5. Case I. Gross specimen of kidney with tumor mass.

The two cases to be reported in this article show the nodular type which corresponds to the description in Pfahler's paper under the nodular type of metastatic carcinoma of the lungs. It will be observed that nodules are multiple in character, quite discrete and distinct in border outline, although of varying size and density. The nodules are not limited to the hilus region, but can be seen in the parenchyma and just underneath the clavicle as well.

The following case reports are rather typical of the varied symptomatology of hypernephroma. It is unfortunate that the findings in both cases were not definitely corroborated by post-mortem findings. In Case II, the diagnosis of tuberculosis was made by several consultants previous to and after *x*-ray examination of the chest, despite the protests of the roentgen department that this was a case of secondary involvement of the chest, which was subsequently borne out by the facts in the case.

The first case was proved after the kidney had been extirpated, the specimens of which are shown in illustrations accompanying this article. In the latter case the symptomatology was more or less classical, and the diagnosis was clinically suspected. The chest plate in the latter case showed the metastatic areas largely within the hilus region, whereas in the former case the metastasis was throughout both lungs, and was parenchymal in character.

I am greatly indebted to Dr. Barta, of

Marquette University, for the pathological specimens and illustrations.

Case I. Male. Admitted Nov. 16, 1920. Operated upon Nov. 18, 1920. Died Nov. 19, 1920.

Present Complaint. Pain in the right side of abdomen. Flow of blood from urethra, general weakness.

Onset and Course. His pain started last March in the right side. This pain was indefinite at first. It seemed to trouble him most while he was at work. The pain became gradually more severe. It radiated downward toward the pubis. In July, he noticed blood in the urine which had increased in the last two months. During the last few days the blood flow had been almost continuous. He urinated once or twice at night for the past several years. He had not worked during the past two months and felt weak. He lost weight in the early months but regained it .

Past Illness. Appendectomy eleven years ago.

Family History. Mother and father died of old age. No history of malignancy or tuberculosis in the family. Venereal history denied.

General. Appetite fair, bowels regular, no headache, no other pain, ankles never swell, no vertigo, no cough.

Physical Examination. Head. Pupils equal and react to light and accommodation. Teeth in poor condition. Neck shows no enlargement over thyroid, no pulsating vessels. Chest. Symmetrical and expansion equal. Lungs—Breath sounds clear. No areas of dulness, no rales. Heart—Cardiac dulness not enlarged. Apex beat in 5th interspace in nipple line. No murmurs.

Abdomen. Firm and rounded. Liver not enlarged. No tenderness or rigidity. Large mass, palpable in region of right kidney. Extremities—No impairment of function. Reflexes present and normal.

Cystoscopic Examination. Blood clots in bladder. Turbid urine from right ureter; clear urine from left ureter. Indigo-carmine test appears in left ureter in seven minutes. No evidence in fifteen minutes from right ureter. Examination of urine, right ureter, leucocytes, a few colon bacilli, large amount of blood.

Laboratory Findings. Urine, sp. gr. 1:010 acid in reaction, sugar negative, albumen positive, red blood-cells abundant, leucocytes increased.

Blood. Red blood-cells 3,160,000. Hbg. 75 per cent. Color index 1. White blood-cells 6,200. Polymorphonuclear, neutrophiles 75 per cent. Large and small lymphocytes 24 per cent. Endothelial leucocytes 1 per cent. Appearance of erythrocytes normal in shape and size. Wassermann negative.

X-ray Findings. Nodular metastatic involvement in the right side of chest in the region of the hilus.

Pathological Diagnosis. Adrenal carcinoma.

Case II. Male, aged forty-nine. Admitted to Mt. Sinai Hospital, Nov. 10, 1919. Discharged Nov. 23, 1919.

Reason for admission to hospital was the sudden expectoration of blood the night previous to admission. Bloody expectoration continued at intervals since that time. It was not foamy and did not always appear bright red in color. Absolutely denied previous similar attacks. No pain anywhere in the body. No chill at any time. No previous or present cough.

General History. Not subject to headaches, no sore throat, no dyspnea. Has not lost weight for the last four years. Did not catch cold frequently. Feels strong. Appetite very good. No vomiting or pain in epigastrium after eating. No genitourinary diseases.

Past History. No sickness since childhood; no operations. Habits—Indoor work of an executive character, moderate amount of tobacco. No alcohol in the last few years. Meals regular and rests well at night. Venereal—Gonorrhea about twenty-five years ago. He is not married.

Physical Examination. Patient quiet in bed, and in no discomfort, color of mucous membranes good. Not nervous, cheeks slightly flushed.

Head. Eyes, nose, ears were all negative. Mouth—Tonsils large, tongue coated, teeth showed excessive dental work. Neck—Negative.

Chest. Lungs negative, except blowing respiration over a small area on right side of chest anteriorly about level of 3rd rib, mid-clavicular line, also slight impair-

ment to percussion and lessened breath sounds in right apex posteriorly.

Heart. Negative.

Abdomen. Negative.

Extremities. Musculature good. No evidence of emaciation anywhere. Knee-jerks present and active.

No reaction to 5 mg. of old tuberculin subcutaneous injection. Wassermann negative.

Nov. 20, 1919. Examination of chest revealed narrow Kroenig's isthmus left side as compared with right side. Lessened expansion of left base posteriorly. No impaired resonance or rales. Respiration normal throughout.

Daily examination of sputum showed no evidence of bacilli of tuberculosis, but traces of blood.

Temperature on admission was 100.4° F., pulse 110, respiration 22.

Urine Analysis. Negative.

Blood. Red blood-cells 3,220,000. Hbg. 75 per cent. Color index 1. White blood-cells 5,050. Polymorphonuclear neutrophiles 77 per cent. Basophiles 2 per cent. Eosinophiles 4 per cent. Large lymphocytes 14 per cent. Small lymphocytes 2 per cent. Endothelial leucocytes 1 per cent. Appearance of erythrocytes, marked variation in shape and size.

Patient discharged in good condition. Re-admitted to hospital May 24, 1920, having passed a large amount of blood during urination. Physical examination practically as before, excepting that patient was very much emaciated. Remained in the hospital until the date of death, July 14, 1920. Condition grew steadily worse from day to day and emaciation was very rapid. Appearance at time of death was more or less characteristic of the cachexia due to malignancy.

BIBLIOGRAPHY

1. *Virchow's Arch. f. path. Anat.*, xciii.
2. Da Costa. Surgery, Ed. 7. Philadelphia, 1919.
3. *Berl. klin.-therap. Wchnschr.*, 1914, xxxvii.
4. Hyman. Tumors of the kidney. *Surg., Gynec. & Obst.*, March, 1921, xxxii, 216.
5. Young, H. H. Tumors of the Kidney. Osler's Modern Medicine. Philadelphia and New York, 1909, vi, 297.
6. Murphy, J. B. Hypernephroma of the Right Kidney. Murphy's Clinics. Philadelphia, June, 1915, iv, 535.
7. Adami. Principles of Pathology. Philadelphia and New York, 1909, i, 745.
8. Wilson. *J. Med. Research*, 1911, p. 73.
9. Bevan, A. D. Clinic of Arthur Dean Bevan—Hypernephroma. *Surg. Clin.*, Dec., 1920, iv, 1115.
10. Eisendrath, D. N. Clinic of Daniel N. Eisendrath. Congenital cystic disease of the kidney: consideration of tumors of the kidney in general. *Surg. Clin.*, Oct., 1919, iii, 1057.
11. Ransohoff, J. Surgery of the Kidney, the Ureter, and the Suprarenal Gland. Keen's Surgery. Philadelphia, 1910, iv, 244.
12. Keyes, E. L. Diseases of the Genito-Urinary Organs. New York, 1911.
13. Pfahler, G. E. Malignant disease of the lungs, its early recognition and progressive development, as studied by the roentgen rays. Am. J. Roentgenol., Nov., 1919, vi, 575.
14. Moore, A. B., and Carman, R. D. Radiographic diagnosis of metastatic pulmonary malignancy. Am. J. Roentgenol., March, 1916, iii, 126.

ROENTGENOGRAPHIC INTERPRETATION OF ILEOCOLONIC STASIS*

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NEW ORLEANS, LOUISIANA

THE finding of large quantities of the opaque meal in the ileum, cecum and ascending colon after a brisk purgation with one of the saline group or other popular laxatives must make us realize that there can be considerable stasis with regular bowel movements of once or twice a day. This fact has been proved to our entire satisfaction in our service at Touro Infirmary, with the cooperation of Dr. S. K. Simon, the head of the gastrointestinal division. The ileum and first portion of the large intestine up to the splenic flexure are developed from the mid-gut, the terminal section coming from the hind gut; and this development probably plays some part in the pathology of intestinal stasis.

Roentgenological study has shown us that the mass movement of the feces is initiated in the cecum and proceeds in regular rhythmic waves toward the anus. These waves are quite feeble in the first segment of the colon and to a limited extent are opposed by antiperistaltic waves; from the splenic flexure to the sigmoid, the waves are stronger and more uniform, carrying the hardened feces to the pelvic colon, to be expelled later. When through any cause this movement is interfered with, a distinct pathological condition is the result, with an absorption of the toxic products in the ileum and ascending colon, and its resulting long train of symptoms. We have had enough cases go to operation to prove that in most instances that have had no previous interference, the stasis is probably not due to the congenital bands that were first brought forcibly to our attention by Mr. Lane of England, and by Coffey and Jackson in this country.

We place no value on a simple six-hour retention in the ileum and cecum, but a twenty-four- forty-eight- or seventy-two-hour stasis is reported to the clinician as right-sided stasis. We must determine the cause of the pathology: whether the impediment in the flow of the fecal current is due to a mechanical cause, loss of tone, a chronic appendix, a chronic gall-bladder (with or without adhesions) or adhesions from pelvic inflammation and peritonitis, especially of the tuberculous type. We cannot consider malignancy of the bowel, as this is a true obstruction of the lumen. In one instance, the cause of stasis was an enterolith in the ascending colon. Lack of physical exercise, long-standing chronic disease, and chronic toxemic conditions all play a part in this syndrome.

The patient is usually referred for right-sided pain, and in a large number of cases one is informed by the clinician that the appendix or gall-bladder has been removed for the same pain from which the patient is now suffering. There was relief for a while, due to the forced rest following a laparotomy, to the diet, and above all, attention to the bowels; but the patient now has a return of symptoms and sometimes is much worse than before. The case is gone over in our department. All gastrointestinal observations are made in the erect position whenever possible: only for the sake of testing the mobility of the ileum and cecum and the degree of prolapse of the large bowel, are the observations made recumbent. An observation is made in six hours, repeated in twenty-four, a purgative is then given and another observation made in forty-eight hours. If the barium is still present, another purgative is given and a seventy-two-hour observation made. It is at this time I wish to say a word about purgatives—after we have seen, in the hospital routine following a gastrointestinal examination, one of the saline group given, with a notation on the chart of five or six watery stools, when the roentgenogram will show almost the entire meal still retained, as at the previous examination.

I think the saline group is productive of more harm than good. The fecal current is only stirred up, large quantities of water

* Read at the Midwinter Meeting of the Central Section of THE AMERICAN ROENTGEN RAY SOCIETY, Louisville, Ky., Feb. 24, 1923.

are drained from the tissues, the bacteria are more active and generally the patient feels much worse following such a purgative. Castor-oil in tablespoonful doses apparently moves the opaque bolus along better, but the resulting constipation to some patients is quite annoying. Large doses of the cascara and phenolphthalein group do very well, but I think they are considered quite irritating to the kidneys.

The fate of the patient depends largely upon whether the surgeon or the internist refers the case. Our report shows marked intestinal stasis with a Lane's kink with prolapse and acute angulation of the large bowel in the region of the hepatic flexure. If the case is in the hands of the surgeon and he decides to operate under anesthetic with the patient recumbent (remember the observations were made in the erect position) the abdomen is opened, the colon is found in place, due to the relaxation from the anesthetic, the only pathology present is the Lane's kink, and, as a consequence, the roentgenologist is criticized for his opinion. It is here I wish to emphasize that I think intestinal stasis belongs to the domain of the gastroenterologist; and I think we as roentgenologists should insist on the medical side of treatment. Every one of us has lived through the time when on reporting a prolapse of the stomach or large bowel, they were surgically suspended, and the patient returned with the same train of symptoms and in a large percentage of cases much worse than before. We rarely see this today, thanks to the cooperation of the internist and roentgenologist. The finding of a filled appendix which empties and is freely movable is no indication that it should be removed; this is merely a part of the symptom complex of the condition, and removal will do no good.

In this paper, which is only preliminary, I simply wish to bring the subject of intestinal stasis forcibly to your attention, as I think we have been lax in not paying sufficient attention to it in our reports. There is very little to be found on this subject in our literature, although quite a bit on the surgical and medical side, and the roentgenologist must be the final judge of the condition.

A PLEA FOR THE USE OF THE ROENTGENOSCOPE IN THE DIAGNOSIS OF URINARY CALCULI*

BY J. L. TABB, M.D.

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IT IS a frequent occurrence that a patient is referred to a roentgenologist for an examination for urinary calculus, and he finds a vague shadow, which may or may not be due to a stone. It is with no little embarrassment then that he is forced to tell the referring physician that the patient may or may not have a urinary calculus.

It is in the interpretation of these vague shadows that we have found the roentgenoscope to be of the greatest value, when used in conjunction with the opaque ureteral catheter in place, and the visualizing of the bromide solution during the injection of the kidney pelvis and ureter. It is surprising how small a calculus may be and yet show under the roentgenoscope, provided you already know just where to look for it; the approximate location, of course, having been ascertained from a previous plate.

The technique that we employ is as follows: A leaded ureteral catheter is introduced on the suspected side of the patient, and is preferably passed until the kidney pelvis is reached or until it meets an obstruction. The roentgenoscopic examination is begun, and knowing the approximate location of the suspicious shadow, we make a search for it in this region, using a very small beam of *x*-rays. The shadow can usually be found, particularly if the roentgenologist has waited for the pupils of his eyes to become dilated. I cannot emphasize this point too strongly.

If the shadow is not in the region of the pelvis of the kidney and is not in close

* Paper submitted with application for membership in THE AMERICAN ROENTGEN RAY SOCIETY, 1921.

proximity to the leaded catheter, it is certainly not a urinary calculus. Often the shadow will be superimposed upon that of the catheter and by rotating the patient the shadow may be thrown well away from the catheter, thus disproving a calculus; whereas if a plate had been made, the shadow would have been superimposed upon the bromide catheter or shadow, and the roentgenologist would have been forced to rely upon the mechanical effects of the stone on the ureter, such as dilatation, which is often uncertain. If by rotating the patient the shadow cannot be thrown away from the catheter at all, the concretion is definitely in the ureter. Besides, the parallax method of location will show that the catheter and shadow are in the same plane, and palpation of the abdomen will move both in unison. If by rotating the patient the shadow can be thrown only a short distance away from the catheter, the catheter should be withdrawn to a point below the shadow and bromide solution injected. In some cases in which a calculus has formed a pocket in the ureter, the solution may be seen to run to the shadow; if, however, it is not seen to do so, a plate should be made, since a small thread of bromide solution running to the calculus may escape detection under the roentgenoscope, but will be easily seen on the plate.

Often the leaded catheter meets an obstruction, and in these cases the catheter may be seen pointing directly toward the calculus. By using the parallax method the shadow and tip of the catheter are found to be in exactly the same plane. The abdomen may be palpated and any difference in movement noticed so that one is rarely in doubt. In shadows close to the ureteral orifice rotation of the patient is not of much avail, unless the patient is extremely thin, since the thickness of the hips and the ossa innominata obscure the view when the patient is in the oblique position. The parallax method, however, will show the catheter and concretion to be in the same plane, and palpation per rectum or vagina will fail to change this position.

The foregoing applies chiefly to the diagnosis of suspicious shadows along the course of the ureter. Now a word as to the diagnosis of shadows in the region of the pelvis of the kidney. It is very obvious that a concretion in the pelvis of the kidney may be at some distance from the catheter, this distance depending upon which calyx the concretion is in, the height to which the catheter has been introduced, and the shape and size of the kidney pelvis. The parallax method may also show that the catheter and concretion are not in the same plane, but on deep inspiration they will move in unison. When the abdomen or lumbar region is palpated the relative position will not be materially altered. These two points are of great value in the differential diagnosis of biliary and renal calculi, since the gall-bladder makes a more extensive respiratory excursion than the kidney, and it is freely movable on palpation of the anterior abdominal wall.

After observing these facts and viewing the patient from different angles, the bromide solution is allowed to flow very slowly into the kidney pelvis. The solution may be seen to surround or run to the concretion, and while the solution is slowly filling the pelvis, the patient is rotated and palpation is used. It is often the case, where a pyelogram alone has been made, that the bromide solution completely obscures the calculus. Unless the shape of the kidney pelvis is materially altered, it is difficult to say whether the concretion is in the pelvis or simply in anteroposterior alignment with the bromide shadow. By using the roentgenoscopic method this difficulty is overcome, as the density of the shadow caused by the bromide solution gradually increases, and while the concretion is still visible through the solution, the patient may be rotated and palpation used.

If the calculus is in the cortex of the kidney, of course the bromide solution will not reach it, but the concretion and the bromide shadow should move in unison on deep inspiration and on palpation, and the parallax method will roughly show that the difference in their relative horizontal planes is not greater than the thickness of the normal kidney. There are cases, however, in which suspicious shadows cannot

be detected upon roentgenoscopic examination, but these are very few, and in the cases where the concretion may be seen the information afforded by the roentgenoscope has been of such great assistance that at present we employ this method as a routine. I may also say that even in cases where the injection of bromide solution is done for other reasons than the diagnosis of a calculus, we invariably watch the filling of the kidney pelvis and ureter by roentgenoscopic observation.

We use approximately the same milliamperage and spark-gap that we use in ordinary roentgenoscopic examinations of the gastrointestinal tract, namely, 3 ma. and a 5½ in. gap on a rheostate setting, and by regulating the Coolidge control the penetration and milliamperage may be varied inversely.

REPORT OF RESULTS OF X-RAY TREATMENT IN PYORRHEA ALVEOLARIS*

BY G. VON POSWIK, M.D.

SCRANTON, PENNSYLVANIA

WHILE listening to Dr. Hickey, last September, in Washington, reporting results in treating diphtheria carriers and producing negative bacteriology findings within the course of a few hours, the happy thought struck me, that pyorrhea alveolaris might be treated by roentgen rays. As far as we know, there is no curative treatment for pyorrhea. We do not know the exact etiology of that disease, hence all the local and systemic treatments have shown only temporary relief.

The study of oral sepsis is a branch in medicine which has come into prominence during the last few years. The ancient Egyptians knew how to take care of their carious teeth. They replaced lost teeth by gold ones, filled cavities, and even straightened teeth by wire arrangements. The evidence of their skill is found on paintings and also in the mummies which have been exhumed, but there is no evidence of treating pyorrhea.

Is pyorrhea alveolaris caused by heredity? Is it a systemic condition, or are local causes responsible for it? Is it a combination of systemic and local causes?

Pyorrhea may be found where otherwise perfect teeth are present. Bass and Johns of Tulane University thought surely they had found the cause when they demonstrated the fusiform bacillus and Entameba buccalis in the mouths of patients who suffered from amebic dysentery. They based their statements on their experience with the employes who constructed the Panama Canal. Many of then contracted amebic dysentery and the fusiform bacillus and Entameba buccalis were found around the alveoli and in the stools.

Tartar formation is the most prominent symptom. Proper scaling and medicinal applications give relief, but do not effect a cure.

Now what can *x*-ray treatment do? I submit 3 cases, each of a different type, with a prompt clinical result within a short period of time.

CASE I. Female, fifty-seven years old, suffering with intercostal neuralgia and indigestion. She vomits at times, is very nervous, has headaches, and appears to be anemic; had typhoid and the menopause when thirty-three. She had given birth to eight children. Family history was negative. The oral findings are as follows: An upper artificial plate, in the lower jaw some of the molars were extracted. The rest of the teeth were loose. The gums were swollen and spongy, bleeding when touched. On pressure, pus came forth. She informed me that these teeth must come out, as all were loose. She received her first treatment on October 8th. On October 25th, the gums were still somewhat swollen, but there was no pus. Some of the teeth were beginning to tighten. Treatment given. On November 6th, the patient entered with a smile. "My pain is gone and my teeth are improving," she said. Examination showed no pus, the gums were firm

* Read at the Midwinter Meeting of the Eastern Section of the AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., Jan. 25–28, 1923.

and pink, but the teeth were still loose. It looked as if something were missing between the teeth and the mucous membrane. By pulling the gums from the teeth, one could look away down to the roots, but the mucous membrane had a healthy appearance. No treatment was given. Patient reported December 30th, and gums looked healthy and the teeth were firm. She remarked that she could crack nuts with these teeth.

CASE II. Male, forty-nine years old, policeman. This patient was referred to me because the upper centrals, laterals and cuspids were very loose. The rest of the teeth were replaced by a partial plate. This patient suffered from a marked gingivitis. The gums were not quite as spongy as in the first case, but they bled when touched and showed pus on pressure. Had been under mercurial treatment seven years previous. He received his first *x*-ray treatment on Nov. 10th. After one week's time, improvement of the gums was noticed. On Nov. 15th, the patient stated that the teeth on the left side were somewhat firmer. On December 8th, improvement was marked. The gums looked healthy, but another treatment was given. On December 28th, the patient reported the teeth of the left side were firm, while the right cuspids and lateral incisors had improved, but were still somewhat loose.

CASE III. Male, aged forty. Suffering from symptoms of duodenal ulcer. *X*-ray findings proved this diagnosis. Two years previously he had had his appendix removed, and two weeks previously his teeth had been scaled. The examination showed several of the teeth to be loose, and pus could be expressed from the gums. Several painful spots were noticed on pressure over different roots of the teeth. The gums were not as spongy as in the other two cases. Treatment was given. After one week there was a marked improvement, which I attributed to the previous scaling. The painful spots over the roots, which had been proven by *x*-ray examination to be apical pathology, had disappeared. That it was the direct result of the *x*-ray treatment I cannot prove.

My present plans are the following:

1. Take the history of the patient and pay particular attention to the oral conditions.
2. Make a bacteriological examination.
3. *X*-ray examination.
4. Have teeth scaled. Instruct dentist not to use iodine or anything contraindicating *x*-ray treatments. No toothbrush.
5. *X*-ray treatment p. r. n.
6. Weekly inspection.
7. Make bacteriological examination before each treatment.
8. Follow up cases as long as possible to determine whether a permanent cure is established.

The following technique was used with the first patient:

MA.	TIME	DISTANCE	SP. G.	FILTER
6	6	6½ in.	8	Aluminum 2 mm. Wood 1 in. Aluminum 2 mm. Sole leather

but was changed thus:

MA.	TIME	DISTANCE	SP. G.	FILTER
5	4	6½ in.	8	Aluminum 2 mm. Wood 1 in. Sole leather

for the second and third.

FIFTEEN YEARS' EXPERIENCE WITH THE FRACTIONAL DOSE METHOD OF TREATING CUTANEOUS MALIGNANCIES*

BY. J. M. MARTIN, M.D.

DALLAS, TEXAS

MY INTEREST in roentgen therapy dates from 1900. The *x*-rays had even at that early date won a considerable reputation as therapeutic agents in the treatment of skin malignancy. At the third annual meeting of the American Roentgen Ray Society at Chicago in 1902, instructive papers covering the treatment of skin cancer were read by a number of men, prominent among whom was the late Dr. John B. Murphy. These papers were enthusiastically discussed and freely endorsed by members of the society, some of whom are still active. While there was a marked difference of opinion as to the relative value of the static machine and the induction coil as *x*-ray generators, and a great deal was said regarding a correct technique, low and high vacuum tubes, target-skin distance, length of exposure etc., the reported end-results of all of the workers appeared to be excellent. Being new in the field at that time and uninitiated into the mysteries of this therapeutic method, I was forced to the conclusion that skin cancer might be healed with *x*-rays even when the manner of their application varied considerably. The most popular technique at that time required an exposure of ten minutes to the unfiltered rays of a low vacuum tube at a target-skin distance of from 6½ to 8½ in. with a parallel spark-gap of about 3 in. No attempt was made to measure the high-tension current. The exposures were to be repeated every day until redness, heat and itching became noticeable symptoms. At this point it was thought best to stop the treatment for from two to seven days, after which the same method was to be resumed and so continued until the lesion was improved or had disappeared. It was stated that cases were usually kept under treatment for four months or even longer. When we consider that in those days the work was done with the static machine and small induction coils, and that doses were given in inexact terms, we realize that the actual doses administered must have varied widely. This indefinite method of dose administration slowly gave way to the pastilles and photographic strips and finally to the present somewhat imperfect though very satisfactory method of factor determination. No doubt in the not far distant future some more accurate method will be forthcoming; possibly some form of a practical ionization chamber devised to read directly in terms of roentgen-ray intensity.

When the hot wire milliammeter reached a point in its development where it was, in a measure, reliable, we learned that we had been using a high-tension current of approximately 2 ma. in the treatment of epithelioma. Unfiltered doses of 20 ma. min. administered at a target skin distance of 12 in. with a 3 in. parallel spark-gap, would produce a tanning of the skin when repeated three times within a period of ten or twelve days. Six exposures given at two-day intervals would produce a distinct skin reaction, and after ten such exposures a rather active dermatitis was set up which usually healed in four to six weeks.

If we accept the constant $^{45}/_{64}$, advocated by Witherbee and Remer as representing an erythema dose, and substitute our factors in this formula, the dose administered at each seance was approximately one-half an erythema dose. The three exposures would have amounted to one and a half erythema doses and the six exposures would have produced about three erythema doses; while the maximum of ten exposures would have totaled five erythema doses. A day or two elapsed between exposures and in actual practice three such exposures were required to produce an erythema. It seems probable, therefore, that with such a technique six exposures represented two erythema doses and ten exposures represented approximately three erythema

* Read at the Fourth Annual Meeting of the Central Section of THE AMERICAN ROENTGEN RAY SOCIETY, Louisville, Ky., Feb. 24, 1923.

doses. With a gas tube and an unreliable milliammeter, constant duplication of dosage was impossible. The dosage may appear at first thought to be unusually heavy, but it must be remembered that three erythema doses given at one sitting will produce a greater degree of reaction in the skin than will the same

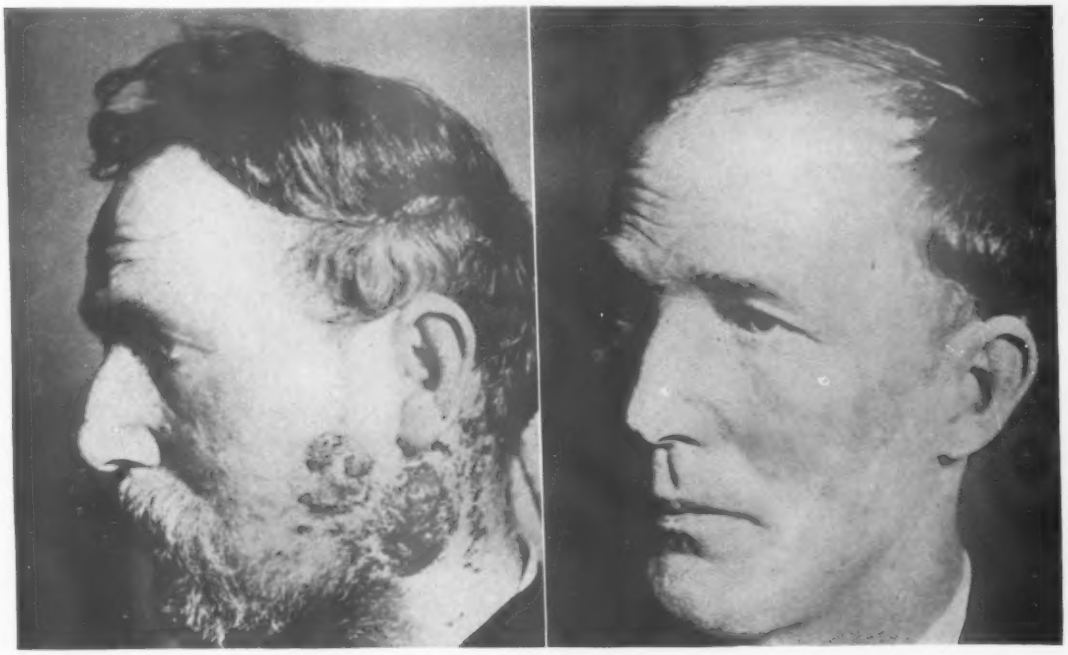

FIG. 1. Epithelioma of the face and neck, declared inoperable. Treated in 1907 with the gas tube, induction coil and the fractional dose method. The lesions healed without complications and the skin is smooth and free from after-effects of the treatment.

FIG. 2. Epithelioma of the temple region treated in 1907 with the induction coil, gas tube and the fractional dose method. The area treated was perfectly smooth and free from after-effects at the time of death from pneumonia, seven years later.

amount of exposure divided into ten periods spaced over a number of days. It is also my firm conviction that very heavy doses must be applied to skin malignancy if the best results are desired. Serious sequellae have not in my experience occurred in the skin following such doses. Bowen has recently stated that he administers a dose at one seance which constitutes about 7.7 erythema dose, according to the calculations of Witherbee and Remer. He shows photographs of patients whose skin appears to be perfectly healed following this procedure.

FIG. 3. Removed by means of seven erythema doses of *x*-rays totaling 175 ma. min. There is absolutely no scar or discoloration over the area treated.

In my earlier work I depended more upon the appearance of the skin during the application of the divided doses than upon the factors used. It was my custom to

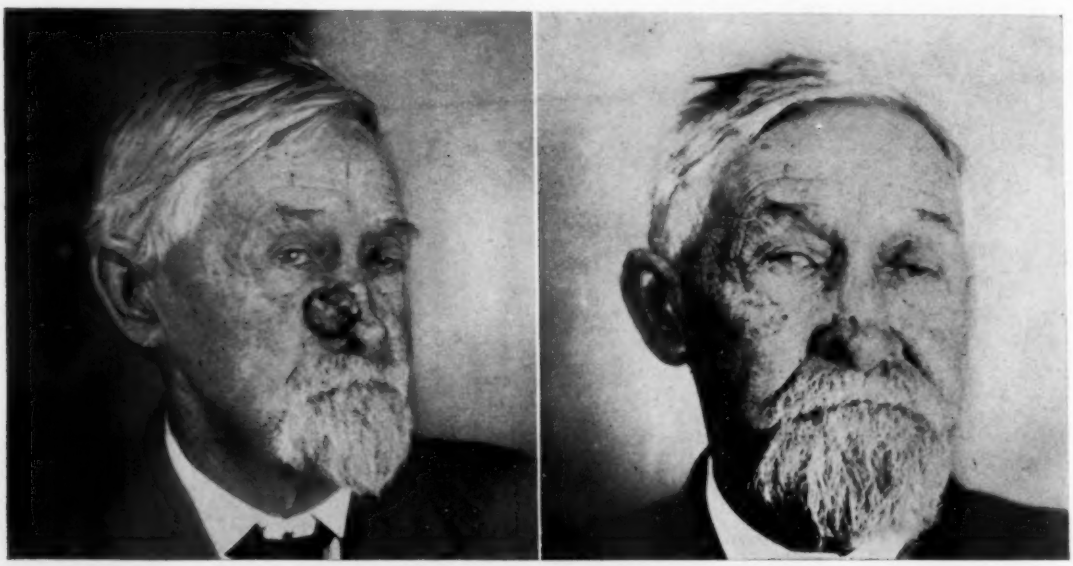

FIG. 4. Epithelioma of the nose completely removed by six *x*-ray exposures totaling 150 ma. min. No deformity exists and a very slight scar remains after more than two years.

administer a dose every second day until a good reaction appeared. This gave me assurance that the patient had received a total dose amounting to much more than an erythema dose. This method still appears to me to be a valuable one since various lesions in different parts of the body in people of different ages seem to react differently. For instance, a reaction appears earlier on the mucous membrane of the lower lip than over the skin of the back. Some of the reactions obtained had a forbidding appearance for a few weeks, but the end-results were for the most part very satisfactory and justified the resulting crusts and exudates that were produced temporarily.

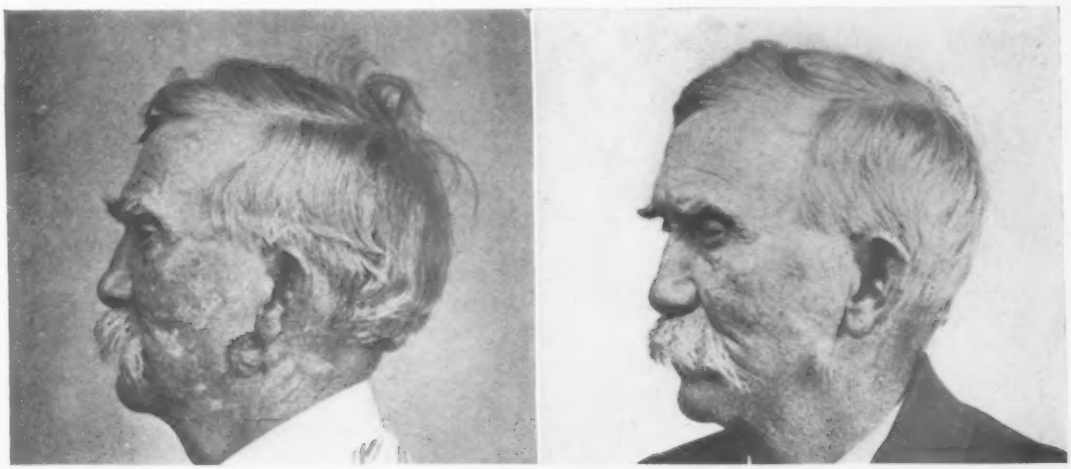

FIG. 5. Epithelioma beneath the ear. After six erythema doses the lesion appeared to heal. Two months later there was evidence of the growth returning. Four additional exposures were given followed by complete disappearance of the lesion.

In 1918 the gas tube was finally replaced by a Coolidge tube energized by an interrupterless transformer. A more radical technique was adopted because certain of the more stubborn lesions had not yielded to one series as previously given. The factors for a single exposure consisted of a 10-in. target-skin distance, a 5-in. spark-gap, 5 ma. of current, ½ mm. of aluminum

FIG. 6. Epithelioma of the temple region completely removed by means of seven erythema doses of *x*-rays totaling 175 ma. min. The skin over the area treated is slightly lighter in color, but there is absolutely no scar to mark the location of this ugly lesion.

placed just beneath the tube, and an exposure lasting five minutes. The exposures were given every other day and the number ranged from two to ten. According to the formula of Witherbee and Remer for filtered dosage, an erythema dose was administered at each sitting. The smaller lesions received from two to four exposures while the growths of moderate size received six exposures. Only occasionally was it found necessary to use as many as ten exposures. The only factor that was varied with this technique was the number of exposures. The rays were, in each case,

FIG. 7. Epithelioma of the face which required nine erythema doses totaling 225 ma. min. There are no undesirable after-effects.

FIG. 8. Epithelioma of the upper lip which responded promptly to six erythema doses of filtered rays, totaling 150 ma. min. The area covered by the lesion is perfectly smooth and the tissues are soft. Two and a half years after treatment there is absolutely no trace of the lesion, the area treated being but a shade whiter than the surrounding skin.

sharply limited, by means of cones and shields, to the lesion and a narrow strip of skin surrounding it. When practical, the skin covering the lymphatic channels draining the area occupied by the lesion was subjected to an erythema dose administered through heavier filters. Fifty ma. min. were given through 4 mm. of aluminum, and four thicknesses of sole-leather with an 8 in. parallel spark-gap and a target-skin distance of 10 in. I have not seen fit to alter this technique and am using it at the present time.

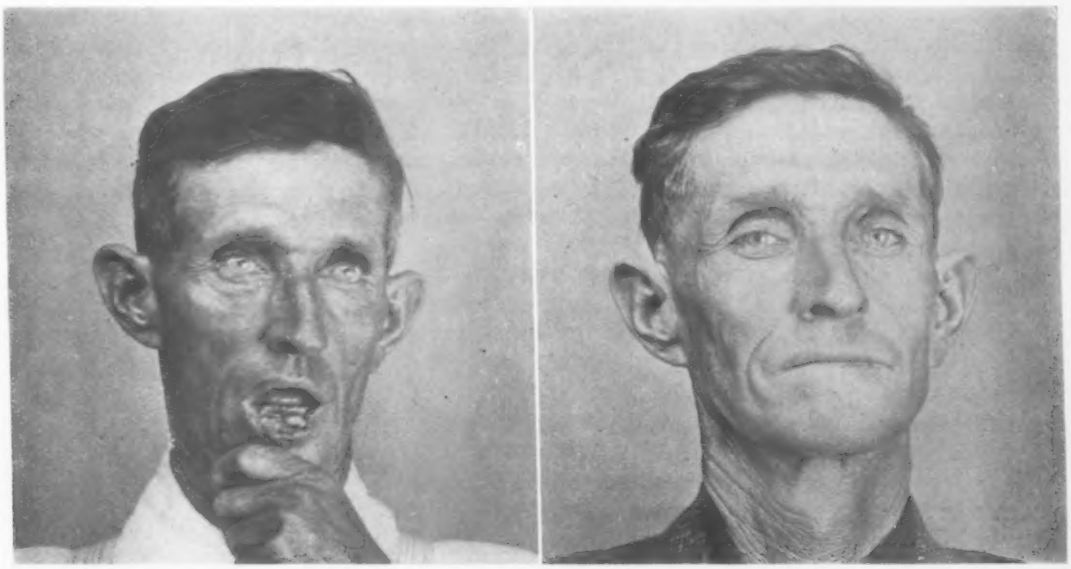

FIG. 9. Epithelioma covering two-thirds of the lower lip. Eleven erythema doses totaling 275 ma. min. given from different positions were distributed over a period of six weeks. Two years after treatment there was no noticeable evidence of the lesion or the after-effects of the treatment.

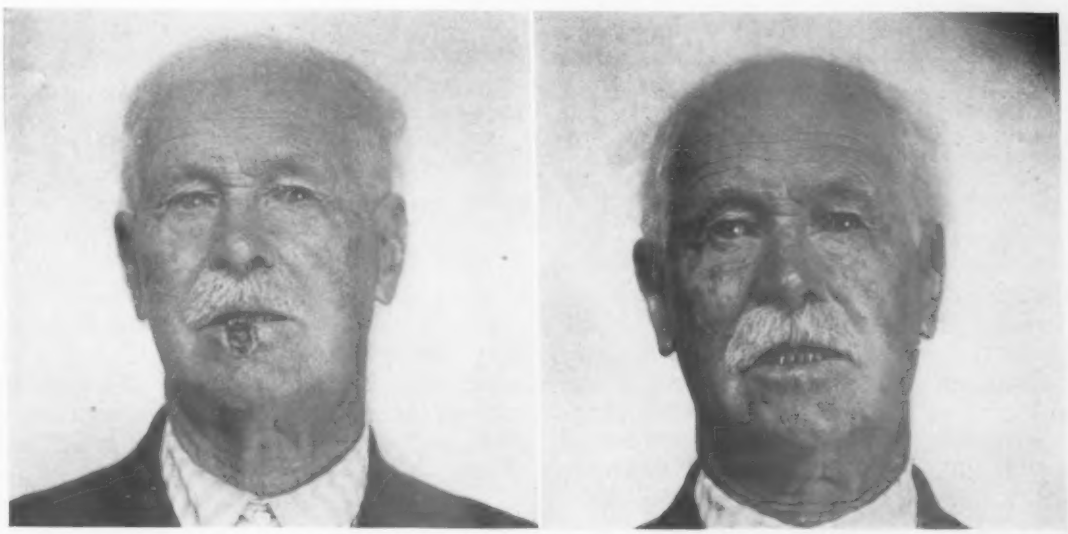

FIG. 10. Deeply ulcerated epithelioma of the lower lip which responded successfully to six erythema doses of *x*-rays totaling 150 ma. min. The treatments were given every second day. There is no scar or other noticeable effect of the disease or after-effect of the method of treatment.

The greater number of my patients come from a distance and as a rule these people are not able to remain under treatment

longer than two weeks, neither are they willing to return at monthly intervals, as is too often necessary when the single exposure intensive method is used. This latter has not been productive of good results in my hands. Perhaps the single doses administered were not large enough. Be that as it may, the majority of the cases treated by the multiple-dose method do not as a rule require a second series of treatments. In all but the small lesions a second-degree reaction is produced, no matter how large the growth may be or where it is located. Many will, no doubt, question the advisability of this procedure, but my experience has strengthened my belief that the treatment of cancer must be radical. Continuous attempts at therapy will often do more harm than good. Results are never so good when it is found necessary to ray again a lesion that was insufficiently rayed a month or six weeks previously. The neoplasm should be annihilated once and for all during the first series of treatments. In my experience, atrophy, telangiectasis, keratosis etc., are not disturbing after-results. The skin at the site occupied by the lesion often shows some atrophy and occasionally telangiectases are present in small numbers. However, the skin is smooth and soft and shows none of the deformity that so often follows surgery. The changes that do occur are of such slight importance when compared with the original lesion that their avoidance should not prejudice the roentgenologist in favor of insufficient dosage.

We make it a rule to photograph every case before the treatment is started, and at different times during the period of treatment, should anything of interest appear. The photograph is the best of all records. The negatives are never retouched or changed in any way. When the cases of epithelioma are discharged or sent home, they are given ten postal cards with our address printed on the front, and with the patient's number and a few questions on the back, together with a date in red ink, on which each card is to be filled in and returned. These cards are to be returned every six months. Should a patient fail to send in his cards we write him once a year; usually a little before the Christmas holidays. This generally brings a reply and the desired information. Should a patient be dead, our letter will nearly always get a reply from some member of

FIG. 11. An extensive epithelioma covering three-fourths of the lower lip and extending well down on the mucous membrane on the inside of the lip. The growth was a stubborn one. The first series of eight erythema doses was not sufficient to destroy the lesion. At the end of two months there was evidence of return. A second series of six erythema doses was given with successful results. There is no deformity in the tissues or unpleasant after-effect after more than three years. There is a slight degree of atrophy and the skin over the area treated is thin, noticeable only to one who understands the cause. Two heavier filtered doses were applied to the areas over the jaw and neck on either side. No other method of treatment was used.

the family. This follow-up system is simple, inexpensive and is meeting with splendid success. In the course of time we hope to have some statistics that will be dependable. We have been following our cases in this manner for only four years. Had we started this follow-up system with photographs and complete records ten years ago, our statistics on *x*-ray therapy for skin malignancy would at present cover over 2,000 cases and would offer strong evidence in favor of the technique described in this paper.

From long experience we are of the opinion that repeated erythema doses of *x*-rays in the treatment of malignant conditions of the skin are productive of better results and more lasting effects than single-dose methods. Our conclusions are based upon an experience of more than fifteen years during which we have treated more than 2,000 cases.

DISCUSSION

DR. ERSKINE. In the smokers who had malignancies what percentage of them habitually held the cigar on the other side from which the lesion appeared?

DR. LAWRENCE. I am using the single-dose method. My experience also dates back to the time when all of us used fractional doses. Cures were very satisfactory at that time, but now I am using the single-dose method without filtration, giving one full erythema dose. A month later, when the lesion is completely healed, I give one filtered dose a little short of erythema. We can cure these cases by either method, but the single-dose method is time-saving and to me more satisfactory. I use electric coagulation on all cases showing an elevated growth.

DR. MARTIN (closing discussion). Answering Dr. Erskine's question, I have no record of a single case of epithelioma of the lower lip where the lesion appeared on the opposite side from that on which the cigar was held. In regard to the smoker with a lesion of the lower lip, it is my experience that the majority of people who have lesions of the lower lip are smokers. Many of the cases shown came into the office with cigars between their lips, and had they not been smoking at the time, I am so sensitive to tobacco smoke, that I could have detected the odor on their clothing or breath. I believe that most roentgenologists of experience agree with me that these people must discontinue smoking if satisfactory results from *x*-ray treatment are to be obtained. After the lesion has been removed a return to smoking increases the danger of a recurrence of the lesion.

Lesions that have not responded after two or more series of *x*-ray exposures appear to have established a sort of immunity to *x*-ray influence, and further treatment should be discontinued. I prefer to receive cases that have not been previously treated by *x*-ray methods.

The erythema dose mentioned in this article is based on the methods of Witherbee and Remer. Personally, I do not believe there is any such a thing as a standard erythema dose. The amount of *x*-rays that will redden the skin of one individual may not make the least noticeable change in the skin of another individual. In heavily-filtered doses of deep therapy a slight tan may be produced after an hour's exposure and the time may be doubled without producing a serious dermatitis. Neither do I believe there is a standard single carcinoma dose. Certain doses recommended may inhibit the carcinoma cells and many of them may be actually destroyed but, in my opinion, some of them often escape actual destruction and may break through the induced fibrosis and set up a recurrence months later.

Through the technique of repeated doses I strive to destroy actually every cell in the lesion by producing an active tissue destruction. The results of such treatment have been shown in the slides and pictures. I would be much gratified if I could get the same universally good results from single exposures.

RADIUM NEEDLES IN MALIGNANT GROWTHS OF THE TONGUE: THE TIME FACTOR

BY A. JAMES LARKIN, M.D.

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IN malignancies of the tongue, eight- to ten-hour applications of radium needles give best results. Reports are given herewith of five malignant growths in which the time factor was varied designedly. In all cases, standard twelve and one-half milligram needles were used.

These cases present fairly similar characteristics in that all were men between the ages of fifty and sixty years, all were in good general condition and no lesion was of more than eight months' duration. Microscopic sections revealed squamous-cell sarcoma in 4 and mixed-cell sarcoma in 1, the latter diagnosis seeming to justify the rather destructive dosage employed. The needles were placed 1 cm. apart, since clinical experience seems to indicate it. Approximately 13 per cent of the hard beta rays are available from standard steel needles.

In the cases reported the needles were placed parallel 1 cm. apart at or 1 mm. beyond the periphery of the induration, and homogeneously distributed through the center of the lesion. In each case the lymphatics draining the area were irradiated to the skin tolerance dosage with gamma ray.

Brief case records are as follows:

CASE I. Male, aged fifty-five. Good physical condition.

Lesion. Present six months; size and shape of an almond; raised, ulcerated, cauliflower, bleeding, indurated and painful. Located in the central portion of the margin and ventral surface of the right side of the tongue. No palpable lymph-nodes. Microscopic diagnosis, squamous-cell carcinoma.

Treatment. Nov. 17, 1921. Four 50 mg. needles inserted about the periphery for six hours—300 mg. hrs. Lymphatic area irradiated with gamma ray.

Course. June 1, 1922. Lesion did not entirely disappear. Apr. 3, 1923. Patient alive, has extensive recurrences involving the site and the floor of the mouth.

CASE II. Male, aged fifty. Good general condition.

Lesion. Present 8 months; 3 × 2.5 cm. on left margin and ventral surface of middle portion of the tongue, indurated, ulcerated, friable, bleeding, with but little pain. No palpable lymph-nodes. Microscopic diagnosis, squamous-cell carcinoma.

Treatment. Sept. 5, 1922. Eight 100 mg. needles inserted parallel, 1 cm. apart in and at the periphery of the induration for eight hours—800 mg. hrs. Lymphatic area irradiated to skin tolerance dosage with gamma ray.

Course. Jan. 15, 1923. Lesion healed. Smooth small white scar, no glands. Gain of 10 lbs. Apr. 3, 1923. Lesion healed, no palpable lymph-nodes, no pain.

CASE III. Male, aged fifty-seven.

Lesion. Present six months. Ulcer 1.5 × 1 cm. left dorsum of tongue, punched-out border. Induration for 1.5 cm. beyond ulcer margin. Several palpable lymph-nodes on both sides of the neck from .5 to 3 cm. in diameter. Microscopic diagnosis, squamous-cell carcinoma.

Treatment. Feb. 20, 1923. Eight 100 mg. needles inserted 1 cm. apart in and around the periphery of the lesion for ten hours—1,000 mg. hrs. Lymphatic area heavily irradiated with gamma ray.

Course. Mar. 26, 1923. Lesion healed, no induration, firm rubbery condition with depression at site of ulcer. Apr. 3, 1923. Lesion healed, small depressed white scar, lymph-nodes same as before treatment.

CASE IV. Male, aged fifty-five. Fair general condition. Lost some weight.

Lesion. Present four months. Left half of tongue from base to within 1 cm. of tip, involved in induration ulcer 3 × 2 × 1 cm. No palpable lymph-nodes. Patient complains of headaches. Microscopic diagnosis, squamous-cell carcinoma.

Treatment. Oct. 14, 1922. Eight 100 mg. needles inserted parallel 1 cm. apart into one-half of the lesion, for twelve hours—2,400 mg. hrs.—repeated two days later in the other half.

Lymphatic area irradiated to skin tolerance dosage with gamma ray.

Course. Oozing hemorrhage with large

slough involving whole ulcerated area. Crater 3.5 × 3 × 1.5 cm. present. Dec. 22, 1922. Ulcerated crater still present; patient in coma for three days. Died of metastasis to the brain.

CASE V. Male, aged fifty-six. Fair general condition. Lost some weight.

Lesion. Present three months; size of small hen's egg, smooth, hard, ulcerated superficially, with broad pedicle, non-indurated base. Located on anterior portion right margin and ventral surface of the tongue. No involvement of lymph-nodes. Microscopic diagnosis, mixed-cell sarcoma.

Treatment. Jan. 17, 1923. Eight 100 mg. needles inserted into pedicle close to base for eighteen hours—1,800 mg. hrs.

Course. Feb. 17, 1923. Lesion completely sloughed off, leaving broad sloughing area 3.5 × 3 × 1 cm. encroaching markedly into normal tissue. Reaction severe. Patient weak. Lost 20 lbs. Apr. 3, 1923, ulceration 1 × 1.5 cm. healing. Crater in the tongue. Patient much improved. No involvement of lymph-nodes.

CONCLUSIONS

1. Standard needles containing 12.5 mg. radium element placed 1 cm. apart and parallel in malignant growths of the tongue yield the best clinical results if left in place eight to ten hours.

2. Six-hour application permits of recurrence *in situ.*

3. Twelve and eighteen-hour applications produce excessive sloughing with tendency to hemorrhage and such severe reactions that the patient's local and general resistance are seriously lowered.

THE RADIUM EMANATION SLIDE RULE FOR USE IN THE FIELD OF THERAPEUTICS

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THE convenience and usefulness of the ordinary types of slide rule are well known and appreciated by those accustomed to its use. Divided with special scales for the solution of particular problems in certain fields, the slide rule has many times in the past been applied to very great advantage, and we are hopeful therefore that it may serve in the field of therapeutics as well.

Taking the Mannheim type of slide rule, we have substituted for the trigonometric and logarithmic scales on the back of the slide, two special scales, one (marked F, Figure 1) for computing the decay of radium emanation and the other (marked E) for computing millicurie-hours by finding the integral of the strength of the radium emanation into the time, or

$$\int_o^t A_o e^{-\lambda t} dt = A_o \left(\frac{1 - e^{-\lambda t}}{\lambda} \right)$$

The logarithmic scale, or what is often called the scale of equal parts, has been divided upon the front side of the slide between the B and C scales, thus permitting all the operations possible with the regular Mannheim rule, except those of finding sines and tangents.

To use the special scales the slide is reversed, thus bringing the emanation decay scale, F, over the logarithmically divided scale lettered D; and scale E, which we might call the dosage scale, under the logarithmic double scale A.

The decay scale, F, figured in days, is one of equal parts due to the fact that the emanation decay is exponential. This is clearly seen to be the case when it is remembered that the slide rule geometrically adds logarithms and that log $e^{-\lambda t}$ is proportional to the time t.

To use the decay scale, F, either the right or left end mark, the proper one being found by trial, is brought over the strength of the emanation on the contiguous scale D; and under the time in days and hours on scale F, is read on scale D, the strength which the emanation will have that many days and hours later. As with any slide rule, the values on the D scale can be considered as multiplied by any multiple

or sub-multiple of 10, and in the computation the decimal point placed by inspection. There is little likelihood of confusion in this if it be remembered that the emanation decays to $\frac{1}{10}$ value in about thirteen days.

When it is desired to find the strength of the emanation more than twelve days later, the slide must be shifted twice. Thus for example, if the initial value of the emanation is 83 mc. and we wish to learn what strength it will have on the seventeenth day, we place the right end division or right index of scale F over 83 on scale D, and under 7 on scale F, we read 23.5+ on scale D. The cross-hair of the glass runner is then placed over this point on scale D and the slide is shifted to bring the left end mark under the cross-hair. Then under 10 on scale F, we read on scale D the figure 3.88+, which is the value of the emanation at the end of seventeen days.

FIG. 1. The slide rule divided with special scales for computing decay of radium emanation and dosage.

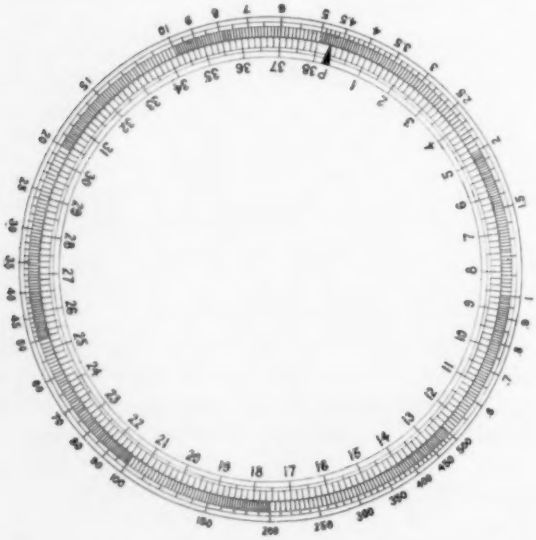

FIG. 2. The circular slide rule for computing decay of radium emanation.

To use the dosage scale E, or better, the scale for computing millicurie-hours, the proper division of the E scale is placed under the initial strength of the emanation on scale A, and over the number of hours for the application on scale E is read on scale A the number of millicurie-hours, a factor in the dosage.

The decimal point in this computation is placed either by inspection or according to some very simple rules.

Another form of rule, and one which we have found much easier to use when only the decay of radium emanation is to be computed, is circular in form. It consists of two concentric rings held together by a tongue and groove, thus allowing one ring to slide within the other.

The outer ring is divided with a logarithmic scale corresponding to scale D of the straight rule but repeated three times and figured from 500 down to 0.5 mc. The inner ring is divided with a scale of equal parts corresponding to scale F of the straight rule but figured in days up to thirty-eight days.

Since in practice it is seldom necessary to compute quantities of emanation greater than 500 or less than 0.5 mc., the circular rule in most cases can be used without the necessity of keeping in mind where the decimal point should be placed.

To use this rule, the wedge division on the inner scale is placed over the initial value of the emanation on the outer scale. Under 1 can be read the value of emanation one day later; under 2, the value two days later, and so on up to thirty-eight days. It is unnecessary to shift the relative position of the rings for any time less than thirty-eight days. The inner ring is divided into parts, each equivalent to four hours, but for accurate work, fractional parts of these may easily be estimated.

In contructing the different scales described above, the decay constant λ has been assumed to be equal to .00751.

FLAT DIAPHRAGM OF SPIRAL DESIGN IN ROENTGENOGRAPHY

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APPARENTLY the only design that is practical for a flat grid or diaphragm in roentgenography is the spiral. This design is not only practical, but has many features that are well worthy of consideration. Firstly, it reduces to a minimum the unavoidable space between patient and film. Secondly, it obliterates completely the grid shadows irrespective of the length of exposure. Moreover, it is very efficient in the filtering out of scattered rays, although no attempt is made to give figures in this respect.

In construction of the disk proper, cork was used as a spacer. The filtering element (lead strips) were 0.5 in. deep, and spaced 0.125 in. apart, making a ratio of one (1) to width, and four (4) to depth. Beginning close to a center, the strips being spaced evenly, they radiate outward to the periphery in spiral form. In radiating outward they gradually form an angle which becomes more and more obtuse. This slanting of lead strips is governed by the distance of tube target to film (26 in.), and allows the primary or image-forming rays to pass without impinging on the sides.

The disk revolves in a suitable circular track of slightly greater diameter. The energy is supplied by a small, high-speed, universal motor, using a small pulley and an endless belt. A circular sheet of aluminum is stretched over as a support for the patient, allowing 0.5 in. for sagging. This makes a space of approximately 1 in. from cover surface to film at any point.

Owing to problems in construction it was found advantageous to use a plurality of spirals. It is not possible, in using four or more strips, to space them evenly in the center. Adjustment can be made, however, that will show a roentgenograph free from lines. Any inaccuracy in adjustment of the center will result in more or less faint circles. These faint lines may be very conspicuous superimposed on, say, a kidney shadow, but may be entirely lost in the varying density of a vertebra.

It becomes apparent that a relatively slow but very even movement is obtained, as the spirals radiate to or from the center. There is a considerable latitude in the choice of speed, but two or three revolutions of the disk per second give freedom from grid shadows for extremely short exposures. As the movement is continuous, no variation in speed is necessary.

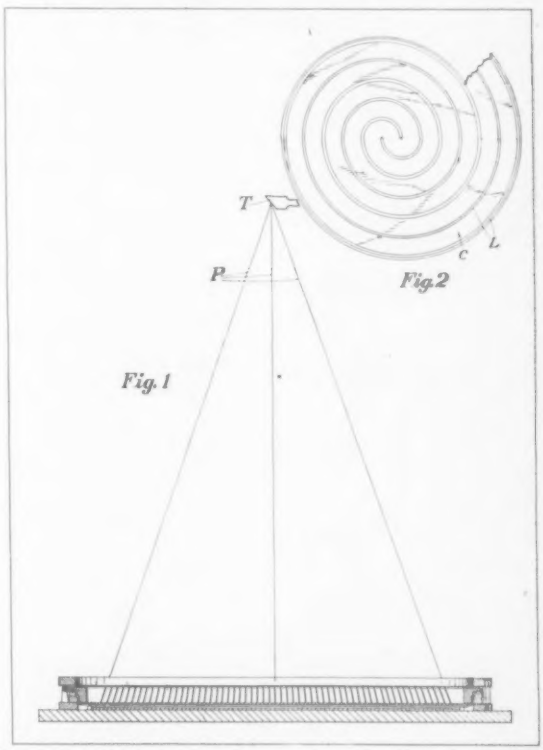

FIG. 1. Diagrammatic section of disk showing slanting strips and their relation to path of primary rays (*P*) from the target (*T*).

FIG. 2. Diagram showing plan of central portion of disk, using two strips. (*C*) Cork spacer. (*L*) Lead strips (enlarged).

It seems interesting to observe the relation of scattered radiation to the spiral. The greater the deviation of scattered rays from the primary path, the more efficient this design seems to be. Apparently 100 per cent efficiency is reached for these most aberrant rays, governed of course by the spacing and depth of strips.

With a ratio of one (1) to width, and four (4) to depth and with penetration equal to a six-inch back-up spark, an excellent clean-up is obtained on average thickness. If higher penetration is used, there seems to be some improvement if cones are used to limit the area rayed.

The suppression of scattered radiation by the use of grids or diaphragms apparently increases greatly the length of exposure. The shadows of the lead strips cover a relatively small area of the film. Theoretically this indicates rather, that a normal or correct exposure is permitted by filtering out the scattered rays. In view of the results obtained, it is reasonable to assume that the spiral type of disk can easily be reduced in depth to 0.25 in. or less. It is obvious that the increase in definition will compensate for efforts along this line.

Many thanks are due to Dr. A. Sophian and Dr. A. C. Clasen for their kindly criticism and encouragement.

BIOLOGICAL REACTIONS OF X-RAYS: EFFECT OF RADIATION ON THE NITROGEN AND SALT METABOLISM

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NUMEROUS studies of the effects of radium and *x*-rays on the metabolism of man and animals have been carried out. However, the experiments recorded in the literature are so scattered and the conditions outlined by the different investigators so variable that it is almost impossible to correlate the data in such a way as to secure reliable composite results. Since the advent of the so-called "blood chemistry" a large amount of data, very inconclusive indeed, on the effect of radiation on the composition of the blood have been reported. These variations, in the main, are probably due, as shown by our experiments, to the different periods of blood withdrawal after radiation. Since the blood equilibrium adjusts itself very quickly, marked changes in the blood will only be noted either during the radiation period or at very short time intervals thereafter. Furthermore, since the introduction of "deep ray" therapy for the treatment of malignant disease no extensive metabolism studies are available which would be of value in interpreting the effects of this type of treatment.

In general, previous investigations have shown that there is an increase of the total nitrogen output in the urine after treatment with radium or *x*-rays. Of the various nitrogenous compounds which might be expected to have been increased after such a treatment, the uric acid is the only one about which there are any consistent data. This compound is found to be increased most markedly in the postradiation periods of leukemia patients. This increase of uric acid is interpreted as being due to the decomposition of the nucleoproteins. This view seems to be substantiated by the observations that the total phosphorous elimination is also increased under similar conditions.

In undertaking this work it was thought that perhaps by a very careful control of conditions and simultaneous analysis of the organic and inorganic metabolites, the metabolic changes as evinced by urinary excretion might be more marked and give some clue as to the mechanisms of tumor destruction. However the net results of these experiments outside of the new and strange behavior of the chloride metabolism were somewhat disappointing. Nevertheless, the data seemed worth while reporting since they present a rather complete organic and inorganic metabolic study of the two types of *x*-ray therapy under comparable conditions.

EXPERIMENTS

Three cases, a carcinoma of the uterus, a lymphosarcoma and a lymphatic leu-

kemia were studied. Before commencing the experimental period, these patients were placed on their special diets for four to five days and maintained on these for the duration of the experiments. Great care was taken to obtain an accurate record of the amount of food ingested. The urine was collected for twenty-four-hour periods and special precautions taken to obtain complete samples. Any doubtful samples were rejected. The urine was preserved with toluene and kept in the ice box.

For the substances determined we employed the following methods:

1. Total Nitrogen. A macro Kjeldahl method using 1 to 5 c.c. of urine was employed. The digestion mixture was that recommended by Folin and Wright.[1]

2. Urea. This was estimated by the urease method of Van Slyke and Cullen.[2]

3. Creatinine and Creatine. Folin's method[3] was used.

4. Uric Acid. This was usually determined by two independent methods, that of Folin[4] with the precautions outlined by Pucher[5] and the direct method of Benedict and Franke.[6] The latter method gave good results on normal urines but considerably too high values as compared with the Folin method in the postradiation periods.

5. Amino Acids. The method recently developed by Folin[7] was utilized.

6. Ammonia. This was evaluated by the microchemical method of Folin and MacCallum[8] substituting titration for nesslerization.

7. Chlorides. Whitehorn's[9] and Volhard's methods were used.

8. Sulphates (Inorganic and Total). The total sulphates were determined by the Benedict[10] method. The inorganic sulphates were also determined gravimetrically as barium sulphate.

9. Phosphates. Organic and inorganic phosphates were estimated by the colorimetric method of Bell and Doisey.[11]

10. Acidity. This was estimated by titration with n/10 alkali.

11. Carbon Dioxide. The urine was equilibrated at alveolar air tension and the carbon dioxide estimated in the Van Slyke apparatus.

The reliability of each method was determined by each of us analyzing the same samples independently with different sets of reagents and apparatus. No method was utilized until our independent results could be duplicated within at least 5 per cent.

Case I. Male, aged fifty-five years. Lymphosarcoma.

Treatment: "Deep ray" therapy.

Past History. Illness began March, 1922, with involvement of the glands under the arms and of the neck. In April the inguinal region was also enlarged. No treatment was received by the patient before coming under our observation.

Present History. In September a lymph-node was removed from the axilla and diagnosed as lymphosarcoma. At that time the patient had large nodes on both sides of the neck in the axillae and in the inguinal region. These nodes increased in size very rapidly. His blood count, except for a slight lymphocytosis, was normal. On November 15th, about two months after his *x*-ray treatment, the patient was reexamined and his nodes had almost disappeared except in the right and left groin, where they were still slightly enlarged.

Experimental Period. The patient was placed on a purine-free diet on the 12th of September. The diet consisted of 2,800 calories with 80 gm. of protein, the calculations being made from a diet chart. This diet was always completely consumed except on the two days of *x*-ray treatment. On the 26th of September the breakfast only was consumed. It consisted of 836 calories with 16 gm. of protein. On the 27th of September part of the breakfast was refused, leaving for the whole day 2,275 calories with 79 gm. of protein. Since previous experiments have shown that patients generally refused to eat their whole diet one to two days after the *x*-ray treatment, no attempt was made to determine an exact nitrogen balance, as in food value experiments. The same difficulty was encountered in animal experimentation.[12]

Discussion of Data. It will be observed that already within twenty-four hours after the treatment there is a slight increase of the total nitrogen excreted. This value, of course, is low since only part

of the diet was consumed, but nevertheless distinctly higher than the average value (10.4 gm.) of the total nitrogen excretion during the normal period. In the following two days, during which the whole diet was consumed, the total nitrogen excreted change in the creatinine or creatine metabolism could be detected. The uric acid nitrogen, which, due to the purine free diet, was of endogenous origin, showed in the normal period an average of 0.074 gm. N per twenty-four hours. This value was

TABLE I

RADIATION SHEET

CASE I. SEPT. 18–OCT. 7

Date	Time, Min.	Area Radiated	Size Skin Area	Filter Copper	Sp. Gp.	Ma.	Focal Skin Dist.	Skin Dose	Per Cent Depth Dose	
9–26	36	L. neck	15×15	5	200	6	50	70	36	"Deep Ray" Therapy
	36	R. neck	10×15	5	200	6	50	70	36	
	36	L. neck	10×15	5	200	6	50	70	36	
9–27	36	R. neck	15×15	5	200	6	50	70	36	
	36	L. groin	10×15	5	200	6	50	70	36	
	36	R. groin	10×15	5	200	6	50	70	36	

	Vol., C.c.	Sp. Gr.	Total N	Urea + $N.H_3N$., G.	Amino Acid, N	Uric Acid, N	Creatinine, N	Creatine, N	Chlorides, Gm.	Inorganic Phos., Gm.	Organic Phos., Gm.	Total P. Cal.	Weight, Kg.	Remarks
18–19	660	1.027	10.4	9.1	.....	.....	.....	.....	....	.....	.....	.....	75.3	2800 cal.—80 gm. protein‡
			11.1*											
19–20	930	1.025	11.2	10.6	.....	0.074	0.478	0.00	6.15	0.425	0.008	0.433	75.0	2800 cal.—80 gm. protein
			9.06*											
20–21	1225	1.021	9.13	2.56	.....	0.06	0.375	0.065	8.15	0.328	0.0098	0.338	73.0	2800 cal.—80 gm. protein
			10.64*											
21–22	1690	1.017	11.14	9.88	0.157	0.076	0.464	0.066	11.05	0.595	0.011	0.606	....	2800 cal.—80 gm. protein
			9.4*											
22–23	1955	1.011	9.87	8.68	0.120	0.073	0.427	0.100	6.80	0.612	0.026	0.638	....	2800 cal.—80 gm. protein
			10.31*											
23–24	1350	1.019	10.64	9.67	0.136	?0.033	0.417	0.061	7.20	0.842	0.025	0.867	73.7	Basal metabolism = +18.9%
			9.88*											
24–25	1550	1.017	10.89	9.06	0.257	0.086	0.396	0.079	8.30	0.693	0.03	0.723		
25–26	1100	1.022	9.62	.....	.....	0.078	0.414	0.074	6.60	0.664	0.04	0.704	73.1	Basal metabolism = +21.4%
			10.08*											Treatment†
26–27	1415	1.021	11.41	9.59	.....	0.049	0.405	0.099	5.09	0.999	0.023	1.022	....	836 cal.—16 gm. protein
			12.8*											
27–28	1645	1.017	14.03	12.2	.....	0.148	0.42	0.110	4.25	2.1	0.104	2.204	....	2275 cal.—79 gm. protein
			14.27*											
28–29	1832	1.016	14.97	13.6	.....	0.145	0.438	0.085	2.06	1.37	0.108	1.478	....	Node diminishing rapidly in size. 2800 cal.—80 gm. protein
			9.25*											
29–30	1385	1.017	9.43	8.69	.....	0.155	0.35	0.05	4.95	0.755	0.025	0.755	....	2800 cal.—80 gm. protein
			9.45*											
30–1	1285	1.020	9.21	8.98	.....	0.072	0.40	0.00	6.59	0.675	0.025	0.700	....	2800 cal.—80 gm. protein
			8.72*											
1–2	1055	1.024	9.57	8.28	.....	0.068	0.367	0.011	6.10	0.700	0.012	0.712	....	2800 cal.—80 gm. protein
2–3	Lost													
3–4	980	1.020	8.95	7.97	.....	.....	.....	.....	.....	.....	.....	.....	72.7	Basal metabolism = +19.6%
4–5	1084	1.019	9.9	9.12	.....	.....	.....	.....	4.55	.....	.....	.....		
5–6	1390	1.018	10.9	9.72	.....	.....	.....	.....	5.66	.....	.....	.....		

* = Total nitrogen calc. from fractions determined.
† = See radiation sheet.
‡ = Patient on purine-free diet (see Experiments).

increased 35 and 44 per cent respectively. On the fourth day after the radiation, the normal nitrogen output was again reached and remained constant until the 6th of November when the observations were discontinued. It will be noted that this increase in total nitrogen is due chiefly to a parallel increase in the amounts of urea and ammonia excreted. No appreciable increased one day later than the total nitrogen and also returned to normal one day later. The average increase of uric acid nitrogen was 100 per cent over that in the normal period.

Since we obtained an increase of endogenous uric acid which undoubtedly is due to the destruction of nuclear material, one should also expect an increased excretion of

the total phosphorus. This is confirmed by our experimental data, but it is interesting to observe that the phosphorus increase more closely parallels the increase of total nitrogen than that of the uric acid. This indicates that there is a retardation in either the formation or excretion of the uric acid. This increase of phosphorus confirms the data of other investigators.

As far as we were able to determine, no changes of the chloride metabolism under the influence of *x*-rays are reported in the literature. It will, however, be noted in this case, and especially in Case III, that there is a very pronounced decrease in the amount of chlorine excreted after the radiation period. This decrease is not due to changes in the salt content of the diet nor to a water retention, since no edema or change in body weight or decrease in urinary volume was observed after the *x*-ray treatment. The patient suffered no rise in temperature after the treatment. His average excretion of chlorine was 7.7 gm. during the normal period, while three days after radiation it had decreased to 2.06 gm.—a change of 72 per cent.

Case II. Male, aged fifty-eight years. Lymphatic leukemia.

Treatment: Light radiation.

Past History. The patient first noticed the enlargement of his glands about eight months ago. Since that time the enlargement has been progressive and he has lost about 60 lbs. in weight.

Present History. He was admitted to the hospital on August 4, 1922, and showed a general enlargement of the lymph-nodes up to the size of a large orange. The spleen was markedly enlarged, the lower pole being about 4 in. below the costal margin. On August 8th a node was removed from the axilla and diagnosed as lymphatic leukemia. Bleeding from the operation scar continued for several days. When admitted, the patient had a slight anemia (65 per cent hemoglobin) and 250,000 leukocytes, chiefly small lymphocytes. His blood platelets were extremely low. The patient received three *x*-ray treatments over the spleen and showed marked improvement both as regards decrease in the number of leukocytes and size of the nodes of the neck and axillae.

Experimental Period. On August 9th the patient was placed on a purine-free diet consisting of about 2,400 calories with 80-90 gm. protein. The protein values recorded in Table II are based on the actual amount of food consumed. The collection of our experimental data began on August 14th.

Discussion of Data. The table indicates a normal and three postradiation periods. The amount of radiation, as indicated by the data, was the same in all three periods, but the patient showed a marked reaction only after the third treatment. It was during this period that similar effects on the metabolism as recorded in Table I were observed. It will be noted that in this, as well as in the preceding case, the value for the total nitrogen as determined and as calculated from the partial nitrogen fractions checked within a few tenths of a gram. However, during the increase of the nitrogen after the *x*-ray treatment the difference between those two values was as high as two grams. This large difference disappeared as soon as the nitrogen excreted became again normal. The nature of this undetermined nitrogen has not yet been established. It will also be observed from the table that the increased elimination of uric acid following the radiation is accompanied by a tremendous increase (9.1 mg. per 100 c.c.) of the blood uric acid.

The decrease in the excretion of the chlorides was much more pronounced than in Case I. The decrease persisted for six days, reaching a minimum of 0.74 gm. of chlorine in twenty-four hours. After this day the patient was placed on a high salt diet, but nevertheless even after forty-eight hours the retention of chlorides still persisted.

Case III. Female, aged thirty-eight years. Carcinoma of the cervix uteri.

Treatment: "Deep ray" therapy.

Past History. Illness began in January, 1921 with bleeding from the uterus.

Present History. Gynecological examination on July 17th showed a large ulcerating tumor of the cervix with infiltration of the parametria. Microscopic diagnosis of excised tissue indicated carcinoma.

TABLE II

RADIATION SHEET

CASE II.—AUG. 14–SEPT. 16.

Date	Time, Min.	Area Radiated	Filter, Al.	Voltage, Kv.	Ma.	Distance, In.	
8/18/22	7	Spleen anterior	7 mm.	85	5	10	Light Radiation
8/26/22	7	Spleen posterior	7 mm.	85	5	10	
8/ 9/22	7	Spleen posterior	7 mm.	85	5	10	

Date	Volume	Sp. Gr.	Acidity	Total N	Urea N	Ammonia N	Amino Acid N	Uric Acid N	Creatinine N	Creatine N	Chlorides as Cl	Inorganic P	Weight Basal, kg.	Metabolism, Per Cent	Blood Urea	Chemistry Uric Acid	Leukocytes	Remarks
13–14	760	1.026	434	12.65* 12.23	11.03	0.894	0.163	0.133	0.464	0.00	3.57	0.352	76.0	+47.1	27.9	...	224,000	1635 cal.—63 g. protein‡
14–15	790	1.030	395	12.1* 11.59	10.35	0.902	0.171	0.173	0.514	0.00	4.26	0.528	....	.....	27.9	3.8	.....	2552 cal.—100 g. protein
15–16	680	1.026	...	10.07* 11.70	8.24	0.905	0.215	0.227	0.448	0.033	3.60	0.401	....	.....	....	...	245,000	2577 cal.—102 g. protein
16–17	700	1.028	336	10.48* 11.24	8.58	0.991	0.239	0.187	0.440	0.048	3.72	0.326	....	.....	....	...	.....	2600 cal.—94 g. protein
17–18	720	1.026	332	10.13* 10.01	8.29	0.954	0.177	0.187	0.459	0.074	4.59	0.445	78.4	+55.1	....	...	.....	2370 cal.—92 g. protein
18–19	680	1.030	354	9.36* 9.85	7.35	1.115	0.259	0.153	0.425	0.056	3.84	0.400	....	.....	....	...	220,000	Treatment† 2454 cal.—85 g. protein
19–20	870	1.027	348	9.68* 10.20	7.72	1.117	0.172	0.180	0.396	0.081	3.87	0.735	....	.....	....	...	.....	2576 cal.—98 g. protein
20–21	890	1.022	392	9.33* 10.44	7.81	0.761	0.194	0.160	0.337	0.070	4.29	0.910	77.4	+47.5	24.5	3.6	.....	2261 cal.—90 g. protein
22–23	740	1.020	455	8.96* 9.77	7.01	0.950	0.221	?0.317	0.399	0.060	3.06	1.04	....	.....	....	...	.....	2320 cal.—80 g. protein
23–24	565	1.020	352	7.16* 7.54	5.68	0.766	0.210	0.150	0.363	0.00	2.66	.....	....	.....	....	...	.....	2466 cal.—88 g. protein
24–25	1058	1.024	400	14.22* 14.25	11.70	1.5091	0.318	0.100	0.522	0.089	5.70	1.08	....	.....	....	...	.....	2463 cal.—102 g. protein
25–26				9.45*														
26–27	930	1.022	445	9.74*	7.48	1.061	0.143	0.230	0.473	0.067	4.98	0.625	76.4	+47.1	....	Treatment†		2316 cal.—88 g. protein
28–29	1220	1.012	410	9.22* 9.65	7.47	1.166	.....	0.13	0.371	0.078	3.75	0.790	....	.....	....	...	80,000	2473 cal.—90 g. protein
29–30	1505	1.008	241	11.03* 11.16	8.59	1.505	0.160	0.23	0.448	0.100	5.28	0.978	....	.....	....	...	61,000	2443 cal.—95 g. protein
30–31	1443	1.016	140	10.02* 9.93*	7.67	1.58	.....	0.28	0.418	0.078	6.90	0.925	....	.....	....	...	.....	2649 cal.—100 g. protein
31–1	1125	1.008	495	10.30* 10.47	7.86	1.60	0.185	0.13	0.415	0.103	5.93	1.02	....	.....	....	...	.....	2340 cal.—90 g. protein
1–2	925	1.012	102	6.74* 7.02	4.78	1.32	0.191	0.09	0.329	0.035	2.97	0.587	....	.....	....	...	46,000	2499 cal.—86 g. protein 2415 cal.—81 g. protein
9–10	860	1.026	585	10.38* 11.74	8.54	1.19	.....	0.17	0.448	0.04	3.29	1.07	....	.....	....	...	.....	Treatment† 1776 cal.—58 g. protein
10–11	1530	1.020	336	14.31* 16.50	11.24	2.25	.....	0.317	0.433	0.031	3.66	1.74	....	.....	30.8	Temperature = 103°C. 9.1	7,830	1701 cal.—60 g. protein
11–12	1520	1.020	274	14.35* 16.07	10.30	3.36	.....	0.22	0.440	0.033	1.32	2.30	....	.....	....	Temperature = 100°C.		2199 cal.—80 g. protein
12–13	700	1.020	385	8.10* 11.09	6.66	1.02	.....	1.103	0.277*	0.03	0.74	1.60	....	.....	....	...	.....	2170 cal.—78 g. protein
13–14	580	1.020	330	7.50* 8.56	5.95	1.19	.....	0.08	0.307	0.015	1.00	0.600	....	.....	....	...	.....	2022 cal.—80 g. protein
14–15	300	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.51	.....	....	.....	23.8	3.0		
15–16	800	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.98	.....	70.0	+55.4		Put on high salt diet on 9/14/22		

* Total nitrogen calc. from fractions determined. † See radiation sheet. ‡ Patient on purine-free diet (see Experiments).

CASE III.—JULY 23-AUG. 14

TABLE III

RADIUM TREATMENT

Date	Amount, Mc.	Area	Screening	Time	Total Mc. hrs.	
8-2	158.4	Intrauterine	Silver, .5	5 hrs. 6 min.	1854.5	Radium
	212.5		Brass, 2 Rubber	5 hrs. 6 min.		

X-RAY TREATMENT

Date	Time, Min.	Area	Size Skin Area	Filter	Sp. Gp.	Ma.	Focal Skin Dose	Skin Dose	Per Cent, Depth Dose	
8-3	152	Abdomen	20×26	.5	200	4	80	80	50	"Deep Ray" Therapy
	150	Back	20×26	.5	200	4	80	80	50	

TWENTY-FOUR-HOUR SAMPLES OF URINE, JULY 23–AUG. 14

Date	Vol.	Sp. Gr.	Tot. Acid	Tot. Nit.	Urea N	$N.H_3$	Uric Acid	Creatinine N	Creatin N	Amino Acids N	Chlorides	Tot. SO_3	Inorganic SO_3	Ethereal SO_3 Calc.	Total P. Calc.	Inorganic P.	Organic P.	Gm. CO_2	Remarks	Weight 49	Basal M. +4.5
23–24	1280	1008	.....	5.1655	.....	.....	.12	.217	.076	.075	3.888	1.093	.985	.1075	.3567	.35	.0067	.588	‡Proteins 44.4 gm.		
24–25	1290	1005	102	6.289*	5.0623	.642	.112	.2536	.0998	.091	3.	1.097	.614	.4832	.4265	.422	.0045	.0812	54.8 gm.		
25–26	1900	1015	155	4.290 7.539*	6.1163	.7047	.168	.2905	.1165	.115	3.27	1.599	.962	.6367	.645	.628	.017	.205	75 gm.	48.	+ 7.5
26–27	1340	1008	178	7.762 6.299*	5.361	.387	.14	.235	.106	.067	3.43	1.367	.8924	.4746	.4459	.437	.0089	.0722	49.1 gm.		
27–28	2000	1011	266	6.405 8.787*	7.273	.707	.163	.3642	.0848	.123	5.7	1.646	1.206	.440	.6327	.618	.0147	.1811	49.9 gm.		
28–29	1570	1011	80	8.88 6.639	.....	.5856	.156	.248	.130	.122	5.22	1.292	.785	.5071	.4029	.3910	.0119	.2968	55.7 gm.		
29–30	1040	.....	.....	6.48*	5.073	.7417	.17	.248	.1409	.101	2.55	1.353	.8663	.4794	.527	.513	.0088	.2526	55.3 gm.		
30–31	1700	.....	208.9	6.59 8.606*	7.061	.776	.190	.308	.134	.117	3.33	1.404	1.319	.085	.654	.638	.0157	.1983	55.7 gm.		
31–1	1435	1009	169	8.43 6.638	5.521	.4913	.15	.278	.085	.100	3.35	1.248	.889	.358	.418	.410	.0082	.1039	55.6 gm.		
1–2	1310	1011	134	7.287*	6.064	.486	.147	.300	.111	.121	3.19	1.244	.9825	.262	.....	.....	.012	.3312	58.6 gm.	47.8	+ 9.2
2–3	822	1025	84.17	7.309 4.385*	3.598	.2579	.140	.2226	.0556	.0936	6.28	.895	.674	.221	.3881	.3803	.0078	.177	55.6 gm.	Treatment	
3–4	Lost			4.548																	
4–5	580	1018	145	.....	.....	.....	.23	.215	.0704	.111	.93	1.185	.812	.373	.....	.327	.005?	.0417	5.6 gm.	Treatment†	
5–6	925	1009	170	5.39* 5.847	4.116	.554	.23	.244	.100	.103	.948	1.128	.673	.455	.375	.350	.025	.066	2.8 gm.		
6–7	1115	1023	182	6.691* 6.841	5.302	.5725	.23	.27	.129	.106	.714	1.326	.899	.427	.397	.378	.019	.0694	27.6 gm.		
7–8	650	1012	99.8	4.1* 4.42	3.263	.463	.07	.156	.0631	.057	.225	.9555	.6955	.26	.24	.232	.008	.046	31.1 gm.		
8–9	780	1012	159	5.888* 6.004	4.784	.556	.163	.242	.071	.08	.6	1.427	.995	.432	.343	.335	.007	.0422	36.6 gm.	45.7	+ 7.4
9–10	730	1010	127.3	5.158* 5.159	4.31	.437	.12	.208	.034	.078	.426	1.182	.795	.386	.296	.266	.03	.0397	40.7 gm.		
10–11	373	1015	106	4.17	3.075	.354	.06	.16	.026	.043	.144	.9548	.749	.2058	.232	.224	.007	.0202	51.9 gm.		
11–12	884	1010	181	5.514* 6.523*	4.151	.704	.143	.289	.107	.095	.39	1.335	.839	.496	.38	.36	.02	.048	30.1 gm.	46.0	+10.4
12–13	605	1009	80.4	3.944	2.903	.459	.15	.193	.063	.063	.42	.840	.496	.354	.129	.108	.016	.0327	60.4 gm.		
13–14	1065	1007	114.4	5.313	4.074	.528	.22	.292	.0855	.089	.768	1.118	.681	.4356	.238	.216	.022	.067	44.8 gm.		

* Total N.T. Calc. from different fractions determined. † Treatments—see Radiation Sheet. ‡ Diet—see Experiments.

The patient was anemic with 64 per cent hemoglobin and 3,100,000 red cells.

Experimental Period. The patient was placed on her special diet July 19th and collection of urine started on July 23rd. The diet was equivalent to about 1,500 calories with about 55 gr. of protein. This patient generally consumed only part of her diet and refused food for about three days after her *x*-ray treatment.

Discussion of Data. Due to the irregularity of the food intake, no definite conclusions concerning the nitrogen excretion can be drawn. However, judging from the increase of uric acid lasting for three days after the treatment, the data are in harmony with the two cases previously reported (Tables I and II). The greatest change in metabolism after radiation was the enormous retention of chlorides. The normal excretion of chlorides averaged 3.68 gm. per day with an average urine volume of 1,478 c.c., while, after the radiation period (calculated from the time the whole diet was again consumed) only 0.46 gm. of chlorine with a urine volume of 776 c.c. per day was excreted. No gain in weight or edema was observed during this period. The decrease in chlorides is, indeed, far greater than could be accounted for by the volume changes in the urine. Our data also shows that there is a marked decrease in the total amount of carbon dioxide excreted.

DISCUSSION AND SUMMARY OF EXPERIMENTS

The data obtained from these experiments, which cover the fields of both moderate and heavy *x*-ray therapy, confirm and enlarge the data of previous investigators, as regards nitrogen metabolism. The total nitrogen in all cases was increased in the postradiation periods. Of the different nitrogen fractions determined, the urea plus ammonia and the uric acid were the only ones which showed any increase. In the first two cases (Tables I and II) which had tumors that could be readily observed, the increase in the total nitrogen was parellel to the decrease in the size of the tumor. Since we also observed an increased excretion of phosphorous, it is very probable that a great part of this increase of total nitrogen was due to the elimination of destroyed cells. In this connection the increased output of urea and ammonia and of the undetermined nitrogen gives a partial insight into the mechanism involved in the decomposition of those cells destroyed by the radiation.

In CASE I (Table I) the weight of the tumor mass before radiation was estimated at between 200 and 300 gm. It will be seen that there was an increase after the radiation of about 3.6 gm. of nitrogen, corresponding to 22.5 gm. of dry protein. Estimating that the average tumor tissue contains about 10 per cent protein and 80 per cent water it will be seen that 225 gm. of tumor tissue were actually destroyed.

These experiments also indicate that "roengten sickness" is not due to excessive cell catabolism, since Cases I and II having the largest tumors and greatest increased nitrogen excretion were scarcely inconvenienced by the *x*-ray treatments, while Case III, with the smallest tumor and lowest nitrogen output, suffered a very intense postradiation reaction.

The influence of radiation of the inorganic metabolism was most unexpected, in that in all cases a marked retention of chlorides was observed, a retention far greater than could be accounted for by a possible retention of fluids. This is clearly demonstrated in Cases I and II where no decrease in urine volume or gain in weight could be observed. In fact the retention of chlorides was so pronounced in Case II, that not even forty-eight hours after a high salt diet was there a very marked increase in the chloride output. In Case III, although the urine volume decreased one-half, yet the chloride excretion was eight times below its normal value without any gain in weight. How long this chloride retention would have lasted could not be determined in these cases, but animal experiments are in progress which we hope will clear up the mechanism and factors involved in this phenomenon. The changes in the chlorine metabolism are summarized in the following table:

TABLE IV

	Volume before Radiation	Volume after Radiation	Chlorine before	Excretion (Cl) after
Case I.....	924 c.c.	899 c.c.	7.7 gm.	2.06 gm.
Case II....	1319 c.c.	1341 c.c.	4.5 gm.	1.94 gm.
Case III...	1487 c.c.	776 c.c.	3.68 gm.	0.46 gm.

In conclusion, we wish to express our thanks to Dr. B. H. Schreiner and Dr. Th. Mueller of the State Institute for the examination and treatment of Cases I and III. We also wish to thank Dr. Rochester and Dr. Koenig of the Buffalo General Hospital for the use, observation and treatment of Case II. We are indebted to Dr. Bowen for the basal metabolism determination and to Dr. Reimann for the leukocyte counts.

BIBLIOGRAPHY

1. Folin and Wright. *J. Biol. Chem.*, 1919, xxxviii, 461.
2. Van Slyke and Cullen. *J. Biol. Chem.*, 1914, xix, 141.
3. Folin, Otto. *J Biol. Chem.*, 1914, xvii, 469.
4. Folin, Otto. *J. Biol. Chem.*, 1919, xxxviii.
5. Pucher, G. W. *J. Biol. Chem.*, 1922, lii, 317.
6. Benedict and Franke. *J. Biol. Chem.*, 1922, lii, 387.
7. Folin, Otto. *J. Biol. Chem.*, 1922, li, 393.
8. Folin and MacCallum. *J. Biol. Chem.*, 1912, xi, 523.
9. Whitehorn. *J. Biol. Chem.*, 1910, xlv, 449.
10. Benedict, S. R. *J. Biol. Chem.*, 1909, vi, 363.
11. Bell and Doisey. *J. Biol. Chem*, 1920, xliv, 55

DEEP ROENTGEN THERAPY AND SKIN REACTIONS

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THE expressions *radiosensitivity* and *selective action* of a cell or group of cells, with respect to *x*-rays, have not yet acquired a sufficiently definite meaning to be of practical value.

We know, however, that increasing the dose to a definite value, that is, exceeding the limit of tolerance of an organic territory, invariably produces an injury of the skin. With some degree of approximation, therefore, we can establish a criterion of relative vulnerability in the so-called erythema dose previously determined. But it is not uncommon to find that a patient who has been irradiated under the same conditions as many others, will show a few hours or a few weeks after treatment, a skin lesion of variable degree, from a premature erythema which soon disappears, to a burn of the second or third degree which may take several months to heal. If we exclude the possibility of error in technique, and can prove that this patient received the same dose as many other patients, how can we account for the origin of the lesion? Does this patient exhibit a special sensitivity to the injurious action of the rays? Neuwirth reports that a patient lost her hair completely after irradiation for a gynecological condition. Is this a selective diminution of the resistance of a tissue under the action of the rays?

The question of the existence of a *specific* idiosyncrasy for the *x*-rays has often been discussed. The consensus of opinion is that such an idea must be set aside for the following reasons: The pathological phenomenon of idiosyncrasy occurs for minimal doses of the drug or element which brings it about, and its effect, in the organism in general, is manifested by a shock. Feeble doses of *x*-rays should then produce skin lesions which should result in severe burns, ulceration, and extensive necrosis. No one has observed such changes following small doses of *x*-rays. We believe we can exclude the statements of many radiologists who have mentioned idiosyncrasy for *x*-rays in connection with some cases which showed an erythema, a burn, or even an ulcer after short exposures for radiographic purposes.

This important question was discussed at the Tenth Congress of Radiology, in Germany. The general conclusion was that a true idiosyncrasy for *x*-rays does not exist. Wetterer and Schmidt were

most emphatic in this belief. The appearance of a lesion following the use of *x*-rays for a diagnostic purpose is to be attributed to the use of a beam of rays with too large a proportion of very soft radiation, or to the use of too short a target-skin distance. The recommendation was made that a filter of leather or aluminum and a distance of at least 40 cm. should always be used.

But we cannot deny the existence of hypersensitivity and hyposensitivity to *x*-rays. However, we must not confuse this abnormal reaction of an irradiated tissue with absolute specific and selective radiosensitivity. There exists a physiological equilibrium in the cells of a tissue, and if no external cause has disturbed this equilibrium, all the cells should respond in the same manner to an external agency, such as *x*-rays. It is true that the action of *x*-rays on a cell depends on the age of the cell, but this does not explain why a tissue becomes necrotic after the application of a dose of radiation which was harmless to the same tissue in another case. The existence of a disease, a toxemia, or a nutritional disturbance or local weakness of the tissue can explain its greater sensitivity to the rays. Zieck describes the case of a patient whom he irradiated for tabes mesenterica with two doses of 180 F (Fuerstenau units) in the course of fourteen days. The radiation was measured with the Fuerstenau intensimeter and the dose certainly was not large, yet the patient developed very serious abdominal burns. In this case, the patient had little resistance to disease and had undergone many operations (cholecystotomy, gastroenterostomy, appendectomy, nephropexy).

The skin of children is very sensitive to *x*-rays, whereas the skin of very old individuals is less sensitive, and can stand sometimes 100 per cent larger doses than normal. The skin of blondes, and especially of Titian blondes, shows a marked vulnerability, while a dark skin is more resistant. Also different skin areas exhibit different sensitivity to radiation. Seitz and Wintz give the following scale of skin sensitivity: neck, abdomen, thighs, shoulders, face. They conclude, also, that healthy skin does not show variations greater than 10 to 15 per cent in its reaction to *x*-rays.

In the literature of the last few years are reported several cases which developed burns following irradiation, which cannot be attributed to faulty technique. Kurtzahn irradiated the knee-joint of a patient owing to a mistaken clinical diagnosis of surgical tuberculosis. A short time later, a serious burn developed, with ulceration and finally, perforation of the joint. The histological examination of the tissue revealed an old trichinosis. Evidently this had so weakened the tissue that it was unable to stand a dose of less than 50 per cent of an erythema dose. Bogrow and Grintchar attributed the great sensitivity to *x*-rays of tuberculous patients to the tubercular toxins, since no other explanation could be found for the lesions which they obtained. Numerous radiologists have found that when the sacrum is irradiated, the anal fold undergoes a more marked pathological change than the neighboring parts. Not uncommonly, small, therapeutic doses for the treatment of eczema have caused an erythema and burns of the second degree. This may be explained by the fact that the skin of the anal region is weaker and therefore, less resistant to external actions. Seuffert, Warnekros and others point out that syphilis, even if it is not localized, nephritis, diabetes, and diseases of the blood-vessels predispose an individual to *x*-ray burns.

From what has been said so far, we may conclude that predisposition, or the abnormal state of such a delicate tissue as the skin (on account of disturbances due to nutrition, growth, or change, no matter how caused) may render intolerable doses of *x*-rays which for other individuals are therapeutic doses.

It is not our intention in this paper to establish a scale of injuries caused by various doses of *x*-rays. It is well known that the appearance of an early erythema does not necessarily indicate that a burn will follow, although some radiologists have asserted this to be the case; neither is a late injury which appears after many years necessarily preceded by healed burns. Between these two skin effects, as reactions to *x*-rays, there can be no connection, for it is not always evident that there is a single causative factor. If there were, a sure

means to avoid it would have been found. If these effects were due to too large a dose, or to the quality of the radiation, a physical criterion would have been established, which we should not attempt to exceed. But we have noted serious burns where the skin showed previously no alteration whatever, not even the dry state indicative of the limit of toleration of normal skin.

The appearance of an early erythema a few hours after radiation has been attributed to too hard *x*-rays and too prolonged radiations. This can be denied *a priori*, because, in dermatological practice with small doses of soft radiation, early erythema is not rare. It has been shown that the harmful effect of the radiation is identical for soft or hard rays. Here again we must consider predisposition toward the appearance of early erythema on the part of the radiated tissue. According to Breuer, this is not to be attributed to heat, ultraviolet rays, fluorescence, or electric shocks, but to the fact that the vascular system of the tissue is unsound, so that it responds to even small doses with the appearance of an erythema.

The characteristics of this early erythema are its sudden appearance a few hours after radiation, and its disappearance after a few days without special treatment. Its origin is to be sought in the predisposition of the tissue, which, for some reason, not being able to react sufficiently, is liable to be injured by doses not otherwise harmful.

If, however, as we have stated above, there can be no connection with respect to the quantity and quality of the radiation between a very slight early reaction and a conspicuous later one, such as a burn or ulcer, and we look for the origin of these injuries, we must conclude that they can arise only in tissue which has lost, wholly or in part, its ability to defend itself against external disturbances, such as *x*-rays. In this sense, the cause of the cutaneous injuries is an alteration of the underlying tissue by constitutional, nutritional innervation, or, more properly, trophic disturbances. Thus we observe such an injury in tissue which has already been damaged and rendered incapable of defence, either externally, by excessive dosage, or internally, by local or constitutional diseases; in a word, by any cause which may disturb the equilibrium of the cellular system.

Radiologists have been endeavoring to establish the nature and cause of the cutaneous injuries by every possible means. Histological investigations of the various skin strata show that it is the vascular system which suffers most from the radiation. Not that other elements, such as the lymphatics, the fat, and connective tissue, are indifferent to the action of the rays; but, as Rost, Reimer, Scholtz, David, and others have shown, it is the blood-vessels which are easily affected, almost selectively, by the radiations. When these have lost their power of defence, changes in the radiated tissue may even proceed to necrosis. The nuclei of the cells and the network of chromatin are immediately affected by the rays. Evidently every harmful action cannot be the same for every cell, but must depend on the constitution of the cell itself. Those nuclei are most easily affected which are in a state just preceding, during, or immediately after the process of division. The affected territory suffers before a true lesion occurs. The process of healing is longer and more difficult the larger the number of newly-formed cells which were affected and the more serious the injury to them. This may explain why *x*-ray burns do not heal readily. We find the selective action of the rays on the young elements also in the blood-forming organs and embryonal glands. Dermatologists have made use of the selective action of the radiation, for a long time. For instance, if they wish to obtain a permanent epilation, they pull out the hairs four or five days previous to the radiation. By this epilation the regenerative power of the hair follicles is increased, and thus the rays are better able to exercise their destructive action on the newly-formed elements.

The endothelial cells of the blood-vessels are selectively radiosensitive, as indicated by the observation that when the skin is exposed to small doses of *x*-rays, the cells of the epithelium show no change, while the endothelial cells of the blood-vessels immediately beneath the skin show signs

of injury. For larger doses, the epithelium, the fixed connective tissue cells and the lymphatics are injured. It is the vascular endothelium which will recover last.

The capillaries of the corium are affected by very small doses. The first consequence is the loss of elasticity, so that the vasomotor apparatus no longer functions well, and the skin is handicapped in its power of resistance. For larger doses, the lumen of the capillaries becomes smaller, even to obliteration, or an extravasation may occur, with subsequent telangiectasis. The effect on the skin is shown by the appearance of an erythema, that is, with atrophy and pigmentation. When the injury to the tissue reaches a certain intensity, a visible reaction occurs on the skin; according to Kienbock, the degree of reaction for the same area of normal skin depends on the quantity of rays absorbed.

The erythema manifests itself only after the lapse of a certain time, the so-called "latent period." Here we must exclude early erythema, the cause for which is to be found in changes in the tissue previous to radiation. The latent period is the pathological course of the injury caused in the tissues, especially the more radiosensitive elements, namely, the small vessels. In normal tissue, it depends, first of all, on the specific radiosensitivity of the cells. It is shorter for rays of medium wave-length and longer for rays of short wave-length. At the end of the latent period, a definite change in the skin appears, which may vary from a slight pigmentation to a serious erythema. There is a boundary between a rather intense erythema, which, however, heals easily and may be considered as physiological, and one more intense, which is really pathological. This limit is determined by the regenerative power of the cells. A dose which exceeds this limit causes serious alterations. This limit of vulnerability may be reached in two ways. An excessive dose of radiation may have acted on the tissue so long that serious changes may have been brought about, especially in the blood-vessels, so that the nutrition of the irradiated tissue is interfered with. Such a lesion manifests itself after a very short latent period, with a strong erythema, pronounced burn, and tissue necrosis. It is stronger, the heavier the irradiation. In this class are to be included all the serious burns due to gross errors of technique; for instance, omission of the filter, or error in the length of treatment. We may point out that it is useless to ascertain whether hard rays are more injurious than soft, since an excessive dose of any type of rays will occasion such dangerous burns, and the injury is not caused by a special quality of the rays. The tissue thus affected will cease to function, and after months of care a painful cicatrix will form.

But skin injuries may be caused in other ways. As far back as 1911, Iselin mentioned the cumulative action of *x*-rays. Immediately after radiation with small doses, slight alterations are found in the more radiosensitive tissues, namely the blood-vessels. Scholz, in particular, studied these changes microscopically, and found, even on the seventh day, degeneration of the lining of the large capillaries and swelling of the cells, with amitotic nuclear division, up to a partial or total obliteration of the vessels. Recently, David has gone over this work, and, by means of microscopic examination of the capillaries *in vivo*, has noted the smallest changes in the vessels immediately after irradiation. He has established thus that vascular changes are visible under the microscope long before they manifest themselves macroscopically. The vascular elements of transition from arterial to venous swell considerably as a first reaction, while the arterial and venous capillaries are dilated *in toto*. David observed these changes even two days after irradiation, where gross changes were noticeable only after six or seven days. But the most interesting part of these researches is the observation that in tissue areas, which, for any reason, are less resistant than the normal, the changes in the vessels are systematically premature, and present the same characteristic picture. In nephritic subjects, such changes as will take six days in the normal individual to manifest themselves, are visible after three days with an equal dose of radiation. This observation holds good not only for nephritics, but also for vagotonics, and is seen in Basedow's dis-

ease. The skin of these patients recovers more slowly than the normal from the effects of the same dose. That the vessels are influenced immediately has been demonstrated by Mayer, who observed signs of degeneration in the iris, retina, and eyebrows when radiation was used in the neighborhood of the eye.

Skin necrosis does not occur easily when the blood-vessels are injured by *x*-rays. In the first place, all the vessels are not injured to the same extent, and for doses which do not exceed certain limits, the tissue, although its blood supply is limited, tends to recover. The more distant blood-vessels have remained uninjured, and those which have been affected gradually recover and contribute to the nutrition of the tissue.

The same criterion of cumulative action as in the case of poisons cannot be presupposed here. The cells of the blood-vessels, through selective action and other elements of the cutaneous tissue, such as the lymphatics, fat, the fixed connective tissue cells and sweat-glands, are affected, but not in the same degree. If a second irradiation does not follow the first, the skin gradually recovers; that is, first the germinal layer of the epidermis and the hair follicles, second the fixed connective-tissue cells (which, according to Rost, are also seriously affected) then the sweat-glands, and finally all the papillary endothelium, recover. With a new irradiation, even with a smaller dose, the less sensitive cells, which have had time to heal, are able to stand it; but the more strongly affected cells, whose power of defence has been reduced, are further retarded in their recovery, and the resultant lesion may be made worse. The regenerating power of certain skin elements is quite different from that of others. While in three or four weeks the epidermis has healed, the endothelium is still seriously affected. A new dose acts as an extra dose in the sense that it makes the condition of the blood-vessels worse and impairs the nutrition of the tissue. The cumulative action of a series of small doses bears a relation to the latent period for weak doses of *x*-rays. The injury from each individual reaction may be too slight to produce an inflammatory reaction, but the sum total of many small doses can cause a real dermatitis.

Having thus established that the primary injury is to the vascular system, we can understand Reimer's assertion that the less blood a tissue contains the more resistant it is to *x*-rays. Hypoemic skin is less sensitive to *x*-rays (Schwartz), inflammation and consequent hemorrhage increase its radiosensitivity. Schwartz radiated skin previously made hyperemic and obtained an erythema in half the time required for normal skin. Wieting records better results, and avoided serious injuries to the skin by tying the arteries surrounding the tissue to be radiated, providing this area were relatively circumscribed. Lenz and Richter proved that skin made hypoemic with adrenalin is more resistant to the rays, and can withstand for three weeks a double dose of soft rays or a triple one with hard. From these experiments with adrenalin, and the clinical observations of Reimer and others, we may deduce how alteration of the cutaneous vessels by innervation increases intolerance of the cell to the rays. Adrenalin acts on the extremities of the sympathetic nerves and causes vascular constriction; in this sense the tone of the vessels is increased and they are able to offer greater resistance to any external cause. In the contrary case, that is, when, due to innervation of the sympathetic, the tone of the vessels is lowered, it is evident that the vessels must suffer also, and therefore become less resistant to the rays.

Reimer has studied clinically the course of slight *x*-ray injuries in patients in whom he suspected the vascular system to be abnormal, due to innervation. He has reported several important cases, from which the author concludes that when there exists any weakness of the vessels, small doses of radiation may cause serious injuries. De Boer found that after the interruption of the connecting sympathetic branches, atonia is observed in the corresponding muscular system, whereas the reflex of the tendons remains unaltered, or even increases. Reimer observed the same phenomenon in those of his patients whose vascular system was abnormal.

They showed a special hypersensitivity to normal doses of *x*-rays, extensive ulceration resulting, in some cases. One case described in detail is that of a young woman who had vasomotor troubles from youth (menstrual disturbance, irritability of the vessels, pronounced dermographism, slight tachycardia, hemicrania, sudden and profuse perspiration). Her father had been afflicted for many years with cephalalgia, angina pectoris, and had died of apoplexy. Her muscular tone was low, whereas the tendon reflexes were increased. With this patient, as with many others of the same class, serious cutaneous injuries were caused by small doses of rays which would not have caused noticeable alteration in the skin of normal patients. What part in *x*-ray injuries is played by innervation of the sympathetic, cannot be specified at the present time. But the observations of Reimer deserve attention, also the better known fact in *x*-ray practice of the relation between thyroid trouble and skin injuries. It is well known that in the treatment of struma only very small doses may be used. One-third of the ordinary dose will produce a skin effect.

We have seen that there is a cumulative action for *x*-rays. But if we give the proper dose in one treatment, or even repeat it at very long intervals, there should be no more serious burns. Bearing this in mind, it follows that to deliver a sufficient dose to a deep-seated tumor without serious injury to the skin, we must employ heavily filtered radiation produced by a high voltage and applied from a suitable distance.

Radiologists disagreed from the time this method began to be used. Regaud and Nogier distinguished two different types of skin reaction; one, a local inflammation of the epidermis, that is, a radio-epidermatitis, caused by the hard rays, which was quite different from the radiodermatitis caused by the soft rays. The former is superficial, heals more quickly, causes little discomfort, and does not have such serious sequelae as the latter. Bumm and Warnekros were of the same opinion, and, in 1914, published an article that aroused great controversy, because the smallest dose they used in treating uterine carcinoma was at least four times as large as the strongest doses previously used; yet they found no skin troubles except an ordinary reaction, wet dermatitis and excoriations with a tendency to heal readily.

The danger of using many weak doses has led physicists to obtain more penetrating radiation, and now with heavy filters and a considerable distance from the anticathode, it is possible to administer in one sitting a dose which is considered to be sufficient. The skin thus thoroughly radiated cannot remain unaffected; the vessels are subject to serious alterations and are partly destroyed; the lymphatics and the fixed connective tissue cells are injured. But the same skin area is not subjected any longer to radiation; its nutrition is maintained by the few vessels remaining intact, and, although the healing process is slow, we are sure there is no danger of serious skin injuries. We always notice that after a strong irradiation the skin becomes dry and sometimes brittle, and the radiated territory may appear swollen.

Seitz and Wintz, in discussing a case of severe burn described by Heimann, state that the thickening of the skin which always occurs after irradiation constitutes a certain degree of injury. This slight degree of injury due to the hard rays is of no consequence. It remains present for a considerable length of time, causes little or no discomfort, and never proceeds to necrosis. However, this zone must never be irradiated again, otherwise necrosis will follow. In Heimann's case, that part of the skin in which infiltration appeared was irradiated a second time.

Muhlmann attempts to give a physiological explanation of skin infiltration as a consequence of radiation. He has observed this effect in cases treated with both soft and hard radiation. It is more constant and more noticeable in cases treated with small and frequent doses than in those irradiated only once. The adipose tissue of the skin has a tendency to chronic inflammation in the form of induration, which is observed also in cases where the skin showed only an ordinary pigmentation. The radiosensitivity of a tissue may be taken to increase with increase of its

fat stratum, and, therefore, the infiltration is greater and more characteristic in those parts of the body where, physiologically, there is accumulation of fat, especially if the fat be covered with flabby and spongy skin (lower abdomen of old women, region below forehead and jaw). The development of a callus seems to begin immediately after irradiation, and through external causes (compression, trauma) may be painful.

In this connection we may report an observation of Regaud and Nogier. External trauma or trauma caused by operation is not dangerous soon after the irradiation, but it may become so if it occurs a long time after the irradiation. As the vessels and other radiosensitive elements are not injured, trauma may cause no trouble. Later, however, complications may arise owing to changes which have taken place in the irradiated tissue. The course of callous infiltration is extremely chronic; with a larger degree of inflammation necrosis may set in. It is probable that ulcers of the skin caused by radiation, even when not followed by erythema, must be ascribed to this action on the adipose tissue. Muhlmann concludes his observations by advising the administration of only two-thirds of an erythema dose on skin areas having considerable adipose tissue, and the attempt to compress, if possible, the surface to be irradiated by means of a suitable bandage. After three to five months the edematous regions which are not radiated again become normal in consistency and function.

Jungling tries to account otherwise for the nature of this skin edema. We may observe injury to the lymphatics, especially to the endothelium, which is very permeable and readily causes lymphatic stasis. These lymphatic elements possess a relatively large radiosensitivity, for edema thus accounted for is observed in many cases when the skin remains intact or slightly altered. A histological study shows that edema is principally localized in the papillary stratum; the capillary vessels and the lymphatic rifts dilate and show many leucocytes in the periphery. The edema is undoubtedly of an inflammatory nature. The constant perivascular infiltrations which are apparent even with small doses are present many months after irradiation. The infiltration is due principally to the swollen fixed connective tissue cells, from a few lymphocytes and leucocytes. With a larger dose, the edema increases in the reticular layer, with a swelling of the papillae, up to the separation of the epithelium, with the appearance of an injury between the epidermis and the papillary layer. According to the authors, these changes can still heal readily, provided no additional radiation is administered during the healing process.

All these observations and conclusions which have been subject to argument from the beginning of superficial *x*-ray therapy down to the present day of deep radiotherapy, are but the analysis and synthesis of injuries which appear on the skin owing to the correct or mistaken application of a beam of radiation. The erythema dose used as a criterion corresponds to a certain point in the aforesaid scale of injuries, and our technical skill should enable us (1) to reproduce at every irradiation a predetermined skin reaction of certain and easy recovery, readily withstood by the patient, and (2) at the same time, without injuring the surface, to deliver a strong dose of *x*-rays at the desired depth.

Different schools have adopted different degrees of erythema as the standard skin dose. The criterion of skin vulnerability, since it cannot have a pathological limit in the absolute sense, is differently interpreted. Opinions differ as to the degree of the skin lesion which is permissible.

The erythema dose adopted by Seitz and Wintz is that skin change which, caused by hard rays, appears soon after irradiation as a slight redness. After three weeks it has a darker coloration, and in about six weeks is followed by a decided bronzing. They have correlated the biological dose with the reading of a physical instrument. They found that a dose which measures less than 35 units of their electrometric system will not produce the above-mentioned skin changes, whereas a dose of more than 35 units produces a more severe reaction, with a possibility of first degree burns.

Kroenig and Friedrich, following their numerous experiments on tadpoles and on the human skin, employing rays of different composition, adopted, as a biological unit of radiation, an erythema dose. This they could measure by means of an electrometric system of their own. The skin changes which they obtain with their unit dose are much more marked than those of the Seitz and Wintz unit. The erythema dose of Kroenig and Friedrich is identical with the so-called inflammation dose of Opitz, which, in the human subject, produces simply an inflammation of the first degree, accompanied by temporary reddening. From 170–180 "e" of their electrometric units give rise with considerable constancy to the above-mentioned reaction, whereas with 210 "e" a second degree erythema is produced, with excoriation of the skin, and, in many instances, with vesication.

For Warnekros, the definition of an erythema dose in the sense described by Seitz and Wintz, and Kroenig and Friedrich, cannot constitute a definite criterion which can be applied with certainty to every case. He finds in the amount of radiation necessary to produce the reddening and later tanning of the Seitz and Wintz dose, a difference of 30 to 40 per cent in different patients. He irradiates very powerfully, and his criterion of maximum skin dose is that which produces a pronounced dark red coloring of the abdominal skin, with papular separation of the epidermis and a profuse secretion from the raw surface. This dose, according to the author, is greater than the so-called "carcinoma dose" in the ratio of 100–85; the carcinoma dose is thus defined, since it produces a biological effect on carcinomatous glands situated immediately below the surface. The action of so strong a dose on the skin is not serious, and Warnekros states that he has no special injuries to record. The irradiated skin has a tendency to heal readily, and without some special cause there should be no ulceration or necrosis. With this method the entire dose of radiation is given in one sitting. Should thickening of the skin and subcutaneous tissue be observed in ten to twenty weeks, this will become normal.

But there is always the question: Can we, under all conditions of technique, duplicate our dosage? That is, can we always use a beam of rays whose physical properties are identical?

A matter which is becoming of great interest is that of *x*-ray injuries which appear after some lapse of time—the so-called "late effects."

It seemed, after the introduction of hard rays in radiology, that the danger of burns was past. It was believed that the skin could withstand a greater amount of radiation as the filtration was increased. But later, after a very long time, burns were noted. There are cases described in the literature in which severe skin injuries appeared five to six years after treatment, although in no case was excessive dosage used, and it seldom exceeded the erythema dose. However, the evidence points to the fact that in every case, successive doses were administered at short intervals, two to four weeks, and in order to attain the dose considered destructive for cancer tissue, 5–8–10 consecutive treatments were given. The origin of these late injuries, which occur only with strongly filtered radiation, is not to be ascribed to the nature of the rays themselves, but to the selective radiosensitivity of certain skin elements, as we have already seen.

In *x*-ray therapy as practiced some years ago with weakly filtered radiation, the radiologist could note the appearance of a burn as soon as the maximum dose tolerated by the skin was exceeded; when this did not occur, it was evident that the skin would always remain sound, for the rays were so slightly penetrating that the vessels situated below the skin were not damaged. The contrary is true for more penetrating radiation, for it is possible to give strong doses at a depth without injuring the skin. The skin which has been submitted to such strong radiation not only should not be radiated again, but should be protected from external injury (trauma) which may impede nutrition and delay or stop the process of recovery. There should then be no danger of late burns, since the steady improvement in the circulation and the recovery of the vital functions of the elements of the tissue can-

not possibly account for the formation of late ulcer and necrosis. But this is not true if, at the time of recovery of its normal functions, the tissue be radiated again. The injury may not show itself immediately: years may pass; but finally, neither the defensive strength of the organism in general, nor the assistance rendered by the neighboring tissue, can save the tissue and prevent slow necrosis.

No other explanation of late injuries can be found, and the cases recently described in the literature cannot be interpreted otherwise. Waelsch reports the case of a patient who, nine months after the irradiation, was affected by a third degree radiodermatitis. On the skin of the face and neck were left typical scar formations with telangiectasis and hyperkeratosis. The author states that recently a carcinomatous formation developed in the middle of the scar in the cheek. We wonder what part the injury of seventeen years before played in the development of this carcinoma. We are of the opinion that this cannot be dissimilar to *x*-ray carcinoma, which is caused originally by slight and slow radiodermatitis, and may develop uninterruptedly and cause death, as in the case of many radiologists, or it may remain latent for many years, and then, owing to obscure external or internal causes, give rise to irreparable injuries.

We may call attention to the fact also that in the treatment of neoplasms or lymph-glands in the neck by crossfire, we can, without producing any change on the surface, produce at a depth, where the beams overlap, those injuries to the vessels and other elements which we have already described. This crossing of beams of radiation with accompanying dangerous increase of dose, can also take place when the Roentgen-Wertheim method is used. It is important to note that injury may arise from overlapping beams which, separately, would not be dangerous.

Detailed statements of the importance of the physical nature of the rays in deep therapy have been made by Rost, Kroenig and Friedrich, and Seitz and Wintz. The histological examination of tissues injured by radiation led Rost to assert that the injuries are of similar character in every case, whether they are produced by radiation of long or short wave-length. The degree of biological action is dependent on the amount of radiation absorbed in a unit volume of tissue, whence serious injuries may arise from the administration of small doses of soft rays. Kroenig and Friedrich, after many experiments, arrive at the same conclusions. According to them, the biological effect of unfiltered *x*-rays and of those filtered by 1 mm. of copper is equal for equal doses; the biological effect of rays filtered by 8 mm. of aluminum or 1 mm. of copper is equal for equal doses. The same authors were able to establish the difference in biological effect for various intensities of radiation. With a difference in intensity of 1 :8 the magnitude of the biological reaction is dependent on the intensity of the radiation; for equal doses the effect is stronger for the more intense radiation. For a difference in intensity of 1 :5 the biological reaction is independent of the intensity.

During the last few years, since the war, we have noted a new factor contributing to the uncertainty of deep *x*-ray therapy. Skin burns appeared with no apparent cause. Skilled therapists excluded overdosing, predisposition, and every other cause heretofore mentioned. It has been shown that variations in the primary voltage may cause such changes in the tube voltage as to give considerable increase of dose, sufficient to account for all types of injury. Poor coal and defects in the electrical distributing system cause line fluctuations between afternoon and evening from 170 to 250 volts. This is sufficient to cause a good deal of trouble, unless proper precautions are taken.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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TWENTY-FOURTH ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY

CHICAGO, ILL., SEPTEMBER 18, 19, 20, 21, 1923

Headquarters, Meetings and Exhibits: Congress Hotel, Chicago, Ill.

A VISIT TO SOME SOUTH AMERICAN RADIOLOGISTS

BY JAMES T. CASE, M.D., F.A.C.S., D.M.R. & E. (CAMB.)

Battle Creek Sanitarium

BATTLE CREEK, MICHIGAN

EARLY this year it was my privilege to make a journey to the principal cities on the Atlantic Coast of South America in connection with the cruise of a group of Fellows of the American College of Surgeons. On board the "Van Dyck" of the Lamport & Holt Line we sailed from New York on Feb. 10, 1923, calling for a stay of from one to five days in each of the following ports, in the order named: Havana, Panama, Cartagena (Colombia), LaGuayra and Caracas (Venezuela), Trinidad Island, Rio de Janeiro (Brazil), Santos and Sao Paulo (Brazil), Buenos Aires (Argentina), Montevideo (Uruguay), Rio de Janeiro again, and Bridgetown (Barbadoes, British West Indies). Official recognition of the mission of the North American Surgeons was forthcoming from each of the republics visited, the president in each instance except Colombia personally receiving us and our wives at an appropriate occasion. Cordial greetings were extended by the medical profession of the various countries, individually and through the Faculty of Medicine of the University in each city. In Rio, Buenos Aires and Montevideo formal meetings of the Fellows of the College of Surgeons were held in conjunction with the medical or surgical societies, the program being supplied by speakers both North American and South American.

It is difficult for the citizen of the United States who has not visited the wonderful cosmopolitan cities of the southern half of the New World to appreciate their beauty, their culture, their effort to keep abreast of the rapid advances made in medical science in other parts of the world. Indeed, even for one who has all his life been interested in things and doings Spanish, there was a very distinct though agreeable surprise in realizing a visit to such a wonderfully beautiful city as Rio with its million and a quarter inhabitants, Buenos Aires, a second Paris, with nearly two million inhabitants, and Montevideo with four hundred thousand population. We are told that the West Coast cities are not one whit behind in culture and in the natural beauty of their surroundings, and it is our hope one day to achieve a visit to the principal cities of Chili, Peru, Bolivia, Ecuador and the capital of Colombia. Aside from their other charms, all these important South American republics should attract our attention because of their economic and political importance in relation to the future of our

own republic. Brazil has twenty-five million inhabitants speaking Portuguese; Argentine twelve million Spanish-speaking people largely influenced by Spanish, French, Italian, and German ideals, not only in general, but also in relation to medical and surgical practice. The same is true of Montevideo and the republic of Uruguay. More purely Spanish are the West Coast republics, Lima, Quito, and Bogota being considered among the principal seats of Spanish language and literature on the American Continent.

Not only were the surgeons of the College Mission received officially and individually with the greatest cordiality, but those of us who have occupied ourselves largely with roentgenology were accorded a special welcome by the radiologists in each of the cities visited. Especially warm was the attention given Dr. Emil Beck and myself as members of the American Roentgen Ray Society by the radiologists of Buenos Aires and of Montevideo. Every possible facility was afforded for our entertainment and enlightenment as to South American ideals and practice in roentgenology.

In Buenos Aires the "Sociedad Argentina de Radio y Electrologia" held a special session in honor of our visit, on March 16, and the following evening at the famous Jockey Club tendered a banquet to "Dr. J. T. Case and his American Radiological Colleagues." At the society meeting, the president, Professor Alfredo Lanari, in some elegantly worded remarks, voiced the warmth and cordiality of the hospitality which they wished to extend to us, and invited the writer to take the chair as presiding officer of the evening. Dr. Heuser and Dr. Carelli, as well as most of the other speakers, seconded the cordial welcome of the president. The following program will convey some idea of the scope of interest of our southern colleagues in radiological work.

FIG. 1. A scene in the laboratory of Dr. Humberto Carelli, Buenos Aires.

1. James T. Case. Radiological Exploration of the Duodenum (In Spanish).
2. A. and E. Lanari. Hydatid Cysts of the Lung (In Spanish).
3. Humberto Carelli. On Pneumoperitoneum in the Diagnosis of Abdominal Hydatidosis (In English).
4. J. A. Saralegui. Results in Deep Roentgen Therapy (In Spanish).

5. Carlos Heuser. Demonstration of Cases Treated with Deep Therapy (In English).

6. C. Donovan. Radiological Exploration of the Lumbo-Sacral Spine (In Spanish).

FIG. 2. Waiting room in Radiological Institute of Dr. Carlos Heuser, Buenos Aires.

7. F. Merlo Gomez. Demonstration of the Carelli Table (In Spanish).

Dr. Beck was called upon for discussion of several of the communications.

Professor Lanari and his brother gave a well-illustrated discourse on pulmonary hydatids and their differentiation from sarcoma. The diagnosis of hydatid cyst of the lung is one of the earliest and most brilliant triumphs of radiological investigation. (It should be mentioned that hydatid disease is very common in the Argentine. There is scarcely a surgeon of consequence that does not operate upon some scores of cases of hydatid disease yearly and among these the number of pulmonary hydatids is not inconsiderable.) In a case clinically suspected of a pulmonary hydatid the absence of a suspicious shadow permits the immediate rejection of such a possibility; but when on the contrary the radiological examination presents shadows of a character usually considered characteristic of hydatid disease, is the

diagnosis assured? By no means, for there must be a differentiation between hydatid cyst shadows and the various other tumors and diseases which may produce abnormal shadows in the thoracic roentgenogram. The most easily confounded diseases are mediastinal sarcoma, interlobar pleurisy, pulmonary gangrene, pleural effusion, dermoid cyst, and pulmonary abscess.

Pulmonary hydatid cysts usually present shadows highly characteristic of the disease, and the diagnosis is usually simple either with the film or with the screen. This is especially true in dealing with central cysts giving uniform shadows of variable size, rounded or oval, and with well-circumscribed borders surrounded by healthy, cortical tissue. The translucency of the surrounding lung tissue makes the typical opaque shadow of the cyst stand out characteristically. In the presence of a shadow giving such characteristics, the diagnosis offers no doubt; but it frequently occurs, especially in some of those cases where cysts have undergone purulent infection, that the cyst shadows do not present all these characteristics on account of the reaction of the surrounding tissues, resulting in pleural or pulmonary processes which mask the typical shadows. In the majority of cases there will remain some free portion of the cyst not covered by this obscuring process. In others, however, the surrounding reaction materially complicates the diagnosis.

In differentiating pulmonary hydatid cyst from the intrathoracic conditions already mentioned, the history and the clinical signs play a very important part. Dermoid cyst and pleuropulmonary hematocele are, in the Lanari opinion, not distinguishable roentgenologically from hydatid cyst, although some authors have tried to make differentiations. The radiologist simply can confirm the presence of a shadow of a cyst. Certain forms of pleurisy naturally offer confusion, especially the encysted pleurisies, and above all those shadows with rounded contours. The patient should be examined in various positions and from various angles to make the differentiation as complete as possible.

Pulmonary sarcomas frequently present the characteristics of hydatid cyst. This

FIG. 3. A group of American visitors in Dr. Heuser's laboratory, Buenos Aires. Dr. Heuser in white gown, indicated by X.

is true when they are found in the midst of the clear pulmonary field with the well-defined border well known to us all. The differential diagnosis is difficult. Of the differential signs, a few may be mentioned: (1) The intensity of the shadow. In equal volume, the sarcoma is always more opaque than the cyst. It is more difficult to distinguish the ribs through the shadow of a sarcoma than of a cyst: not a very

FIG. 4. Photograph of Dr. Humberto Carelli, Buenos Aires.

valuable evidence, it is granted, yet it is possible to make it of importance. (2) Another sign is an apparent connection with the mediastinum. Sarcomas generally originate in the connective tissue of the mediastinum and one can trace a connection between the tumor and the mediastinal shadow. When neither the intensity nor the apparent connection of the mediastinum permit confirmation of the diagnosis, it is well to wait for a while, watching the radiological evolution of the tumor to see if new signs may not develop. (3) Ordinary sarcoma grows more readily than cyst. The author does not wish to say that this difference can be observed in a little while. Sarcoma sometimes grows slowly, and in more than one case he has found that many months after the first examination it was difficult to prove any appreciable increase in volume. There comes a time, however, when the sarcoma commences to grow brusquely and suddenly, and then the diagnosis is cleared. He believes this is a sign which is sooner or later observed in all sarcomas. When on repeated observation of a presumed hydatid of the lung, there is found a sudden change in size and form of the shadow, which cannot be explained by the clinical symptoms as a reaction to purulent infection, one must reject the diagnosis of cyst in favor of sarcoma.

Professor Lanari is chief of the Department of Physiotherapy in the University of Buenos Aires, his laboratories being located in the Hospital de Clinicas, just across the street from the School of Medicine. Here was found an amply, though not recently, equipped radiological institution, with new apparatus for deep therapy about to be installed.

Dr. Carelli's name is very familiar to most American radiologists, and especially to the readers of our JOURNAL, because of his work on pneumoperitoneum and perirenal emphysema, an extended account of which was recently published in these pages. The special advantages of the pneumoperitoneum method, above all when carried on by the aid of the elaborate and ingenious table constructed by Carelli for the purpose, is easily apparent in the search for abdominal hydatidosis, the resulting improvement in the percentage of correct diagnoses approaching that for lung hydatidosis. One can scarcely imagine a demonstration of a larger number of more interesting roentgenograms, of such a high average quality from the technical standpoint, than were included in this very instructive exposition.

Carelli, like Heuser, is engaged in private practice, the private institutes of these men being models from the standpoints both of art and of equipment for high-class work. I understand Carelli is to be associated with the work of Professor Arce, the leading surgeon of Buenos Aires, in the

new Institute of Surgery of the University of Buenos Aires, one of the most perfectly-equipped surgical institutions in the world. Here, for the first time, I found a public teaching hospital with an equipment ideal from the roentgenological standpoint.

The next paper, by Saralegui, the secretary of the Argentine Radiological Society, was an account of his personal experiences in the new deep therapy. I saw some of this radiologist's work at the Rivadavia Hospital—some neatly performed and illuminating cases of pneumoperitoneum.

Carlos Heuser followed with a lantern-slide and patient demonstration of some of his deep therapy results, his cases in every way demonstrating that in his degree of success he was not one whit behind the work I have previously seen in France and Germany, and quite equal to the success of any radiologist in North America. This speaker had gone to no end of trouble to provide a rich clinical demonstration.

Heuser urges the fact that the rays bring about a cure through their physical effect on the neoplastic cells, as they destroy the colloidal action. Through the vibration of the ray the organism of the cell is dismembered, resulting in a fall of the nucleus outside of the cell and the reabsorption of the dead cell's organism. This results in the destruction of the cells that receive sufficient vibration to kill them; in the lack of which a recurrence of the disease ensues and the cancer redevelops. The foregoing remarks explain why, in many instances, we apparently cure the disease, and yet if the cells are not within the zone of efficient radiation, they are not completely annihilated and reproduce themselves easily in a weakened constitution. Heuser is of the opinion that the radiologist ought to submit cancerous patients to treatment prior to operation so as to destroy partially the malignant cells and thus render them less reproductive. When such a tumor is removed we probably extract one that is not so liable to reproduce itself. By this process better cures will be obtained than by treating the patient during other stages, such as after the operation.

The type of rays employed should be suited to the cells. Some cells are cured with soft rays, others yielding to hard ones. Furthermore, there are certain cells which cannot be destroyed except by other biological means.

Statistics show that the probability of improvement depends upon the location, the class of cell in each location, the condition of the patient's organic activities, and lastly, on the procedure which has been followed to attempt a cure of the cancer.

FIG. 5. Photograph of Dr. Carlos Heuser, Buenos Aires.

Heuser submits as highly valuable data such cases as the prostate, the uterus, sarcomas and carcinomas of large cells. However, in-so-far as carcinoma of the throat, tongue and stomach are concerned, it is not possible to obtain permanent cures, although temporary improvement is achieved extending over a period of a few months. The carcinomas which dissolve rapidly and contract a second infection move very swiftly, while those which disappear gradually are more readily cured.

In regard to uterine fibroids, Heuser succeeded in reducing the volume by 80 per cent, and for the remaining nucleus

he recommends removal, since it is difficult to forecast developments within four or six subsequent years. On his records he has 3 cases of fibroid tumors which were treated between 1912 and 1914, all of whom died in 1921—one as the result of a sarcoma of the lung, another due to cancer of the rectum, and the third in consequence of a sarcoma of the uterus. For this reason he feels that we should remove whatever tumor tissue remains in the abdomen.

Because of lack of time Dr. Donovan consented to have his paper read by title, and the entire audience adjourned to the new Surgical Institute above referred to, where we witnessed the working of the new model of the Carelli table. Those of my readers who did not read Carelli's article in the April issue of this JOURNAL will do well to look it up; there they will find numerous illustrations of the various advantages afforded by the new table.

At the banquet the following evening toasts were proposed by President Lanari and responded to by Dr. Beck and the writer, and Drs. Carelli, Donovan, Saralegui, Edward Lanari, La Marque, Ustenghi, Heuser, and Barragué. In the course of the remarks I heard an explanation of the fact that the Argentine radiologists do not seem over-enthusiastic about their hospital work. We had observed that in the various hospitals (with the exceptions above mentioned) the radiological department seemed to be given scant attention in the way of equipment, and there was a corresponding limitation to the radiological work done, both as to quantity and quality. It seems that in the majority of hospitals, the roentgen-ray departments are regarded as of secondary consequence, and there is therefore but little inducement to work in many of the sanitary establishments where complaints on the part of the radiological workers go unheeded.

The Argentine speakers declared that they were all seeking to achieve success in the cure of cancer by means of the roentgen rays. Unhappily, although it was true that some cures had been attained, they "have not yet emerged triumphantly from the struggle" and are not "as enthusiastic as the Germans" in curing cancer with the *x*-rays—not because they do not utilize the same appliances and identical methods, but because they feel it is "best to reveal the naked truth." They feel, however, that they have made great strides, and today can achieve apparent success where failure hitherto followed their efforts.

All joined in expressing the hope that the friendly relations existing between the radiologists of the northern and the southern continents may become still closer, leading to an "ideal union, working for the cure of the ills which afflict humanity, in an altruistic and generous spirit." Repeated expression was given to the pleasure experienced by our hosts in extending to us their cordial greetings, and, through us, to our colleagues of the American Roentgen Ray Society their grateful thanks for the many courtesies which they receive during their periodical visits to the United States of America.

Dr. Carelli and Dr. Heuser both arranged for visits to their private establishments, as well as to their homes, and to them and their most charming ladies we and our ladies owe a great debt of thanks. As before suggested, the Radiological Institutes of these two gentlemen (the only ones in Buenos Aires I had an opportunity to visit) are models of their kind. A large group of surgeons from the Cruise took advantage of the courtesy of these doctors to witness demonstrations of their technique in deep therapy and in pneumoperitoneum work, especially in the perirenal emphysema of Carelli. For this special work, Carelli is now employing an "oxygenateur du Dr. R. Bayeux" manufactured by Richard of Paris, the maker of the "Verascope Richard," a stereoscopic camera which many of us have admired and used.

In connection with the formal meeting of the American College of Surgeons at the Faculty of Medicine, under the presidency of Professor Arce, the rector of the University, papers were contributed by the college through Dr. Hugh Young of Baltimore and the writer. Dr. Young's paper, given partly in French, concerned the surgical removal of the prostate for various conditions, while the writer's

paper, in Spanish, concerned the employment of the *x*-rays in the postoperative management of surgical cases, especially in the early determination of postoperative ileus, the study of fistulous tracts, studies after gastroenterostomy and other gastrointestinal operations, and for the correct collocation of splints, sounds, drainage tubes and catheters. As I pointed out ten years ago, it is possible to save patients from death by ileus every year in every hospital in the land by the routine employment of bedside apparatus in the study of patients on the third day after abdominal and pelvic operations. It is not necessary to administer barium; simply place a large film with screen underneath the abdomen of the patient, and make a short exposure with the bedside apparatus. The resulting roentgenogram will reveal evidence which is very valuable in confirming or denying the presence of postoperative ileus, for if it exists, there will be an easily discernible distention of the small intestine with gas, the distended coils reaching such proportions that the diagnosis is clear in the great majority of instances without the administration of opaque material.

On arrival at Montevideo, I found a delegation of Uruguayan radiologists waiting at the dock. I was carried at once to the office of Dr. Pedro Barcia by his associate, Dr. Mezzera, where I found a large array of patients awaiting my examination. They were chosen from the cases selected for operation in the surgical clinics planned for the visiting surgeons during the next three days, and I was asked to check over and confirm or deny the findings prior to operation, and then "face the music" during the operative sessions. The experience was a bit of an ordeal, but nevertheless a great pleasure, and one I shall long remember. I saw 4 cases of hydatid cyst of the lung before the fluoroscope that afternoon, besides a long list of other important cases of surgical interest.

Dr. Barcia is a very hard worker, very intelligent and keenly interested in the advancement of radiological work in his country. He and his partner, Mezzera, have a well-appointed private clinic where they work literally from early morning till late at night. Excellent deep therapy technique was practiced here, as well as in the institute of Dr. Carlos Butler, who is associated with Noguiera, a urological surgeon. Barcia, like many of the Argentine radiologists, employed American apparatus for his treatment work. Indeed, a very large proportion of the radiological equipment in the southern countries was of American manufacture.

Dr. Belliure is another radiologist and physiotherapist of Montevideo who was extremely courteous to the American visitors and who deserves special mention for this fact.

Carlos Butler is one of the long-established radiologists of South America. His work has been known to us for many years. He holds the chair of Radiology in the Faculty of Medicine of the University, and is director of the University Institute of Radiology. I had the pleasure of spending a morning with him in the University Institute of Radiology observing his work and looking over his records of past achievements with radium and roentgen therapy. Butler, like most of the other South American radiologists of prominence, has studied much in Europe, and on the therapy question especially in Germany, and he apologized for not having visited us here in North America, on account of his unfamiliarity with English and the rarity of Spanish-speaking radiologists in this country. However, since the United States participated in the Great War many of our radiologists have acquired a speaking knowledge of French, in which language all South American physicians are able to speak, so that this drawback to visits from our Southern confreres should no longer hold. We sincerely hope that all will feel welcome to our shores and to our clinics at any time.

Again, in Montevideo, it was my privilege to deliver addresses in Spanish on two occasions—once in the Medical School on "Some Phases of the Treatment of Hyperthyroidism," and in the amphitheatre of the "Maternity Hospital" a discussion of the "Radiological Study of the Duodenum." Our hearers were generous in their appreciation of our effort to speak in Spanish,

and again expressed through me to the American Roentgen Ray Society an appreciation of the greetings which I brought to them in the name of my colleagues of the society, and of the great advances being made in this country in radiology, both in diagnosis and in therapy, and of the help which this work has been to our colleagues in Uruguay.

All too soon we had to continue on our way to other countries. Rio de Janeiro deserves special mention for the work of Dr. Duque Estrada and his associate, Dr. Campello. Estrada is connected with the Medical School of Rio. I had a brief chat with Estrada on the down voyage when we stopped at Rio, and planned to have much more time with this talented radiologist, but he was called into the interior of Brazil and I failed to see him again. His colleague, Campello, was most assiduous in his attentions, and did all in his power to add to the pleasure and profit of our visit.

Dr. Toledo Dodsworth, known to us in this country through his personal visit to our clinics several years ago, was absent from Rio at the time of my visit.

Portuguese was none too easy to manage, but by speaking Spanish and French, it was possible to make our friends understand perfectly, and Portuguese is so similar to Spanish that it was reasonably easy to understand them.

We did not have time to meet the radiologists in Sao Paulo, but we must mention one man in particular there who is doing excellent work: Dr. Raphael P. de Barros. Neither did we visit Bahia nor Pernambuco. Bahia is the home of Dr. de Souza da O', director of the Department of Radiology of the Faculty of Medicine of Bahia. This radiologist is well known to us by his publication on radiotherapy, "A Cura Dos Fibromas Pelos Raios X," which is an excellent treatise of the subject of the treatment of myomas of the uterus.

Other well-known South American physicians whose names are prominent in radiology are: Dr. Rafael Gonzalez Rincones of Caracas, Venezuela, Dr. Oswaldo Portugal of Sao Paulo, Brazil, Dr. Becerro Bengoa of Montevideo, Uruguay, Dr. Adolfo Kaplan of Santiago, Chile, Dr. Ducchi of Santiago, Chile, Dr. Esteban Compodonico of Lima, Peru, Dr. Luis Becerra of Lima, Peru, and Dr. J. A. Cavelier of Bogota, Colombia.

I have no doubt that I have overlooked a number of names which should have been mentioned; but surely any South American reader of this article will appreciate that it is difficult for one individual in such a short time to cover the ground. Neither have I mentioned the valuable work which is being done in Cuba where there is a large group of men doing excellent radiological work. I was especially kindly treated by Dr. Alfredo Dominguez, one of the port physicians and also a radiologist, who greeted me on the boat just after we entered Havana Harbor, as did Dr. Pedro Farinas, Dr. Rivero, and Dr. Cabrera Benitez. I hope to have the pleasure very shortly of renewing my acquaintance with the Cuban doctors and of furnishing an account of their work to the readers of our JOURNAL.

CORRESPONDENCE

To The Editor:

I am very grateful to Dr. Sheldon for his kind letter[1] in reply to my note respecting his article in the April number of the JOURNAL; and am interested to learn that with his apparatus he finds E_0, the unfiltered erythema dose, is only 2, in the units there used. He refers to the table given in the paper by Drs. Witherbee and Remer as confirming this value. The reference is unfortunate. They maintain that the effect varies as the first power of the spark-gap; he regards it as varying as the square of this gap; also, they define the erythema dose by four different sets of values. Using these values in Dr. Sheldon's expression, $mam \times G^2/D^2$, we find the values: 2.11, 4.21, 3.16 and 6.33. The first of these is the one chosen by Dr. Sheldon; but if we accept his expression as correct, the variations in these numbers are to be ascribed to errors in observation, and their average should be chosen as the best expression of the results of the observations on which

[1] AM. J. ROENTGENOL., June, 1923, x, 502.

they are based. This average is 3.95. Values of this order are to be found in the U. S. Army X-Ray Manual and other publications. It was for this reason that I chose, for purely illustrative purposes, the non-committal, round value, 5, in my note; it agreed with no one, but seemed to be of the proper order of magnitude. It is to be expected that individual determinations of this quantity will show very appreciable variations, depending upon the peculiarities of the subjects, the judgment of the observers, instrumental errors, variations in technique, etc. When observations for determining the effect of the filter are expressed in the manner proposed by Dr. Sheldon in his original paper, these variations are included in that effect and there is no way in which they can be satisfactorily disentangled from it. But if the observations are expressed in the manner I suggested, all effects arising from a fixed error in the quantity R (such as a lead leakage that does not vary with the intensity of the current) will be segregated in the quantity E_0; all effects causing a fixed percentage error in R (such as one subject requiring 10 per cent more radiation than another) will introduce the same per cent error in E_0, in a, and in b. Thus a mere inspection of results obtained by different laboratories, when expressed in this manner, enables one to classify them as regards the natures of the relative errors involved, to pick out those most suitable for study, and to determine the true effect of the filter. It was for this reason, rather than for the purpose of securing an increased precision in the computation of doses within the region of filtration covered by Dr. Sheldon's observations, that I proposed a change in the formula; but incidentally the change permits a more accurate computation for filters less than one millimeter thick.

ERNEST DORSEY.
Washington, D. C.
June 23, 1923.

OFFICERS OF THE CENTRAL ILLINOIS RADIOLOGICAL SOCIETY

At a recent meeting of this society the following officers were elected:

President: James H. Finch, M. D., Champaign, Ill.

Vice-president: Harold Swanberg, M. D., Quincy, Ill.

Secretary-Treasurer: P. B. Goodwin, M. D., Peoria, Ill.

Subscribers to THE AMERICAN JOURNAL OF ROENTGENOLOGY *visiting New York City, are invited to make the office of* THE JOURNAL (69 *East 59th Street, New York*) *their headquarters. Mail, packages or baggage may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; in this case, kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

TRANSLATIONS & ABSTRACTS

BIRKELO, C. C. Bilateral calcification in the Fallopian tubes. *J. Radiol.*, Mar., 1923, IV, 92.

The author reports an unusual case of a woman with a clinical diagnosis of tuberculosis of the right kidney. An *x*-ray study of the genitourinary tract was requested. This examination revealed two small round shadows in the pelvis, one 3 cm. to the left of the median line and the other 4 cm. to the right of the median line and both 7 cm. above the symphysis. These remained in the same position following catharsis, and a diagnosis of calculi in the lower ureters on both sides was made.

An operation was then performed, a median incision being made. There were numerous pelvic adhesions and the fimbriated ends of both tubes were involved so that the lumen was closed in each. The calculi described in the *x*-ray were found, one in each Fallopian tube, and removed. The right ureter was found to be about the size of an adult's middle finger, tortuous and tuberculous. The right kidney was not tuberculous.

It appears that all of the symptoms originated in the tuberculous right ureter and that the calculi found in the tube were not the cause of any pain.

MCCLURE, JAMES, and CLAREMONT, H. ETHELBERTA. Case of inverted pylorus obstructing a gastrojejunostomy aperture. *Lancet*, Apr. 14, 1923, cciv, 750.

A search of the literature has failed to reveal the report of any case similar to that described in this article. This case was that of a young woman, aged twenty-two. The post-mortem examination revealed the following remarkable condition. The pylorus had evidently been divided surgically at a previous date and a posterior gastrojejunostomy had been performed. There was an interval of about two inches between the pyloric end of the stomach and the duodenum. On opening the stomach the invaginated portion of the stomach was seen to be about an inch and a half in length hanging down in the form of a pedunculated polyp into the gastrojejunal aperture and almost blocking it. This case illustrates the danger of invaginating too long a portion of gut, thereby forming a polyp; in this instance it caused an obstruction to the outlet of the stomach. It is possible that in other situations, for example in a lateral anastomosis after resection of intestine, a terminal invaginated portion might similarly be a potential source of obstruction. Knowledge of the possibility of this accident may assist the roentgenologist in explaining some obscure cases of difficulty after gastroenterostomy.

GRYNFELT. Post-traumatic osteoporosis of the bones of the extremities (improperly called atrophy by the radiologists), *Archives D'Electricite Medicale et de Physiotherapie* 124, Apr., 1923.

The author has recently reported two important studies on the subject of the title of this paper, one before the Society of Medical Science of Montpellier and the other at the Academy of Sciences in 1921.

Repeated examinations and the careful studies undertaken with a scientific rigor, of which the name of the author is a guarantee, lead him to some new and previously unreported conclusions.

From this important work, which is eminently instructive, the editor of the Archives extracts the following, which to the radiologist should be of special interest:

1. Demineralization, calcareous atrophy, decalcification—terms habitually employed to designate the particular alteration of bones following traumatism, manifested on the roentgenograms by an increase of the transparency of the bone, and diminution of the clearness of the images furnished by the bony trabeculae, are such improper terms that we should reform immediately in our use of them in the light of the facts set forth by the author.

2. Osseous atrophy of the skeleton appearing suddenly near or at a distance from the initial lesion (more often a more or less infected fracture) is not calcareous atrophy. The clinical, radiological and histological studies of the author prove this clearly.

3. In cases of bone atrophy the amount of fundamental mineral salts is equal to the percentage found in normal bones.

KJAERGAARD, S. Operative versus radiological treatment of fibroids. *Acta Gynecologica Scandinavica* 1: 191, 1922.

This is an interesting discussion of the pros and cons concerning the operative or radiological treatment of fibroids. The basis of the *x*-ray treatment is undoubtedly the risk of the operation and above all the danger of death from it. In this particular case the term radiological refers to the *x*-ray treatment alone. The applications were always made in several series with about three weeks of interval, in the majority of cases the treatments varying from four to six weeks. The treatment was applied to large areas, two abdominal ones in the case of the smaller growths and four in the case of the larger. In a number of instances sacral areas were also employed. Amenorrhea has usually made its appearance after the second or third appli-

cation, occasionally before and sometimes later. After amenorrhea was observed two or three further applications were given, partly to insure that the amenorrhea was permanent and partly to act further upon the fibroids.

Of 84 cases treated with radiation 7 are especially mentioned by the author. Of these the reviewer will refer to one where the treatment was employed temporarily as a preparation for operation, the hemoglobin increasing from 30 to 70 during two months, after which total hysterectomy was performed, the tumor being no less in size.

Another interesting case was a woman of forty-six who for a year and a half had suffered from menorrhagia attended by pain. She was found to have a uterine tumor the size of a child's head. There was nothing to suggest a malignant growth. Under *x*-ray treatment amenorrhea was established and the tumor decreased to the size of an orange. Seven months later she submitted to operation which revealed a capsulated mixed-cell sarcoma of which she died a year later with metastases.

The author summarizes the value of *x*-ray treatment in fibroids as follows:

In a very large proportion of suitably chosen cases the hemorrhage can be controlled (statistics show 90 per cent and more, even close up to 100 per cent). A shrinkage effect on the tumor is less certain, and this applies particularly to certain types (subserous, intraligamentory, cervical fibroids). With *x*-ray treatment one runs the risk of an unfortunate mistake in diagnosis and this treatment may sometimes be a source of immediate danger.

It will thus be perfectly evident that it is of great importance to choose correctly between operation and *x*-ray treatment.

INDICATIONS

There are some types of cases in which the *x*-ray treatment is out of the question, such as infected and necrotic, twisted and incarcerated fibroids; also fibroids requiring treatment during pregnancy and those which give rise to intraperitoneal bleeding. In the case of fibroid polypi which can be shown to be situated in the vagina or at the os uteri, it is agreed that operation is the best treatment.

X-ray treatment should be as far as possible avoided in complicating infections of the appendages, as there is a risk of a dangerous exacerbation. A careful exploration of the appendages is often rendered difficult when fibroids are present, especially in the case of the larger ones. A favorable history as regards infections of the appendages is therefore particularly desirable.

On the other hand, the non-infectious salpingo-oophoritis so frequently found in association with fibroids, hydrosalpinx, etc., is not a contraindication of *x*-ray treatment. In summing up the complications in operation cases which are unsuited for *x*-ray treatment this is often included, but experience shows it to be unjustified.

If there is another lesion in addition to fibroids which demands operation, particularly ovarian tumors, it will be wisest in most cases to remove the fibroids at the same time.

A very important contraindication against *x*-ray treatment is the presence of malignant ovarian tumors, and sarcoma and carcinoma of the uterus. Such complications are not very rare in patients with fibroids (Freund 6.2 per cent, Klein 7.7 per cent, Machenrodt 7.7 per cent).

The author concludes by expressing his well-founded impression that indications such as those he has advanced will determine that the majority of patients ought to be operated on, and the minority—30 to 40 per cent—ought to be treated with *x*-rays.

BEUTTNER, O. Radium treatment of uterine cancer. *Schweiz. med. Wchnschr.*, Feb. 1, 1923, liii, 105.

During the last eight years the author has treated 63 cases of cervical carcinoma with radium. On the basis of this series he believes that the result of radium treatment depends less on the type of carcinoma as determined with the microscope or the exact dosage than on the age and general condition of the patient. The older the patient the better the results. The prognosis of carcinoma in women comparatively young has improved through radium treatment. The author has been much interested in Kotzareff's experiments on fixation of the emanation in embryonic and malignant cells, and hence has employed radioactive bodies given intravenously. On the basis of his experience the author believes that even if it is still an open question as to whether operable carcinomas should be removed surgically or treated by radiation, nevertheless, better results in inoperable cases are attained by irradiation than with the older palliative methods.

BESSER, HERMAN. Actinomycosis of the lungs simulating tuberculosis. *N. York Med. J. & Med. Rec.*, May 16, 1923, p. 623.

The clinical and physical signs of pulmonary actinomycosis cannot be differentiated from tuberculosis. The disease begins with a gradual onset. A cough develops, accompanied by expectoration of a yellowish, white sputum. There is an afternoon rise of temperature and night sweats soon follow. There is progressive

loss of weight, accompanied by malaise and debility.

Pulmonary actinomycosis differs from tuberculosis in its morbid anatomy in that the disease spreads by continuity. In the early period of infection the disease manifests itself in the formation of small miliary tubercles which later coalesce and form large masses. They take on the appearance of a malignant growth of the lungs, and unlike tuberculosis, ignore anatomical boundaries. The infection spreads to the pleural sacs, causing an adhesion between both sacs and finally rupturing through the intercostal spaces and involving the rib structure. Necrosis of the rib develops and resembles a caries of the bone.

The history must be taken into account when interpreting the roentgen findings. The author cites a case in which the clinical and physical findings pointed to a frank, active tuberculosis, but the marked involvement of the lungs and the suppurative process of the ribs, as shown by the *x*-ray, pointed to actinomycosis. This diagnosis was substantiated later by the appearance of abscesses on the chest and back.

PRYOR, J. H. Immobility of the diaphragm, with report of cases of bilateral immobility. *N. York Med. J. & Med. Rec.*, cxviii, 1923, 75.

The author has dealt with 145 cases in which there had been a pleurisy with effusion or empyema. The cases were classified as follows: (1) empyema in the child, (2) empyema in the adult, (3) pleurisy with effusion, (4) pleurisy with effusion and clinical pulmonary pneumonia, and (5) pneumothorax and effusion.

In approximately 16 per cent of cases it was found that the diaphragm remained unimpaired; another 16 per cent exhibited restricted motion on comparison of the two sides; and in 66 per cent of the cases there was complete immobility of the diaphragm on one side.

Fixation of the diaphragm was more commonly a sequela of empyema in the adult than in the child. Empyema is therefore a far more serious condition in the adult. Of 50 cases observed, only 8 showed no immobility or injury to the diaphragm.

Of the 6 instances of bilateral immobility, all were cases of chronic tuberculosis; all the patients had had pleurisy. Shortness of breath was a prominent symptom. On roentgen examination there was observed flattening of the dome of the diaphragm so that the pericardial attachment formed the angle of an inverted V. The heart shadow was long and narrow, its original shape being entirely lost. All these patients became steadily weaker and died in a short time, only one living for two years.

QUINBY, W. C. Perirenal insufflation of oxygen. *J. Urol.*, 1923, iv, 13.

Not all authors agree on the value of the method of perirenal insufflation of oxygen as described by Carelli. Several critical reports have been published, and the author states that the procedure does not give the plates any greater value than stereoscopic roentgenograms made by the aid of the Bucky diaphragm. As to dangers, if the operator has ordinary judgment and anatomical preparation he will not run the risk of mediastinal emphysema or penetration of the bowel. Quinby describes his apparatus and his technique of injection, which is quite similar to that already published by Carelli. One new point by Quinby is his advice to inject the kidney pelvis and to make an *x*-ray exposure from twelve to fourteen hours after the gas insufflation.

The principal contraindication to such perirenal insufflation is the existence of dense adhesions about the kidney such as follow an operation.

AUSTRIAN, CHARLES R., and BAETJER, FREDERICK H. Some unappreciated findings in the lungs of normal children. *Am. J. M. Sc.*, June, 1923, clxv, 831.

The authors found in the study of normal children that variations from the usual accepted findings in health were often present, and it is their purpose to emphasize the need of evaluating such findings as physiological and not as evidence of disease. The study was based on some 200 apparently normal children between the ages of six and ten.

As a part of the report of a research committee for the National Tuberculosis Association, particularly interesting to the roentgenologist is the statement that inasmuch as shadows noted in roentgenograms of the chest of healthy children are dependent often upon alterations that persist as the residua of past infections of the respiratory tract, it is obvious that a careful anamnesis with special reference to all infections is necessary if diagnostic errors are to be avoided. Even a history carefully taken is often unreliable, as minimal infections are soon forgotten by many and among the unintelligent classes even more significant indispositions are not readily recalled. With a proper appreciation of the widest variations that the normal may present from the ideal, the informed clinician is better able correctly to understand the findings of the roentgenologist, and each, cooperating with the other, is less liable to error.